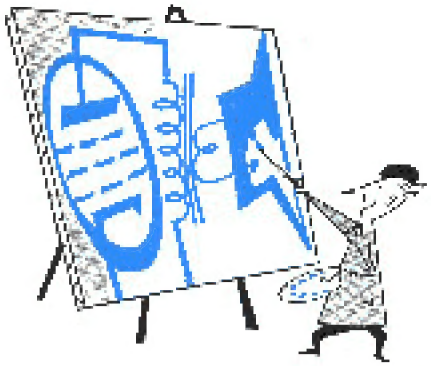


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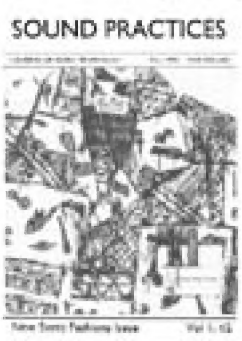
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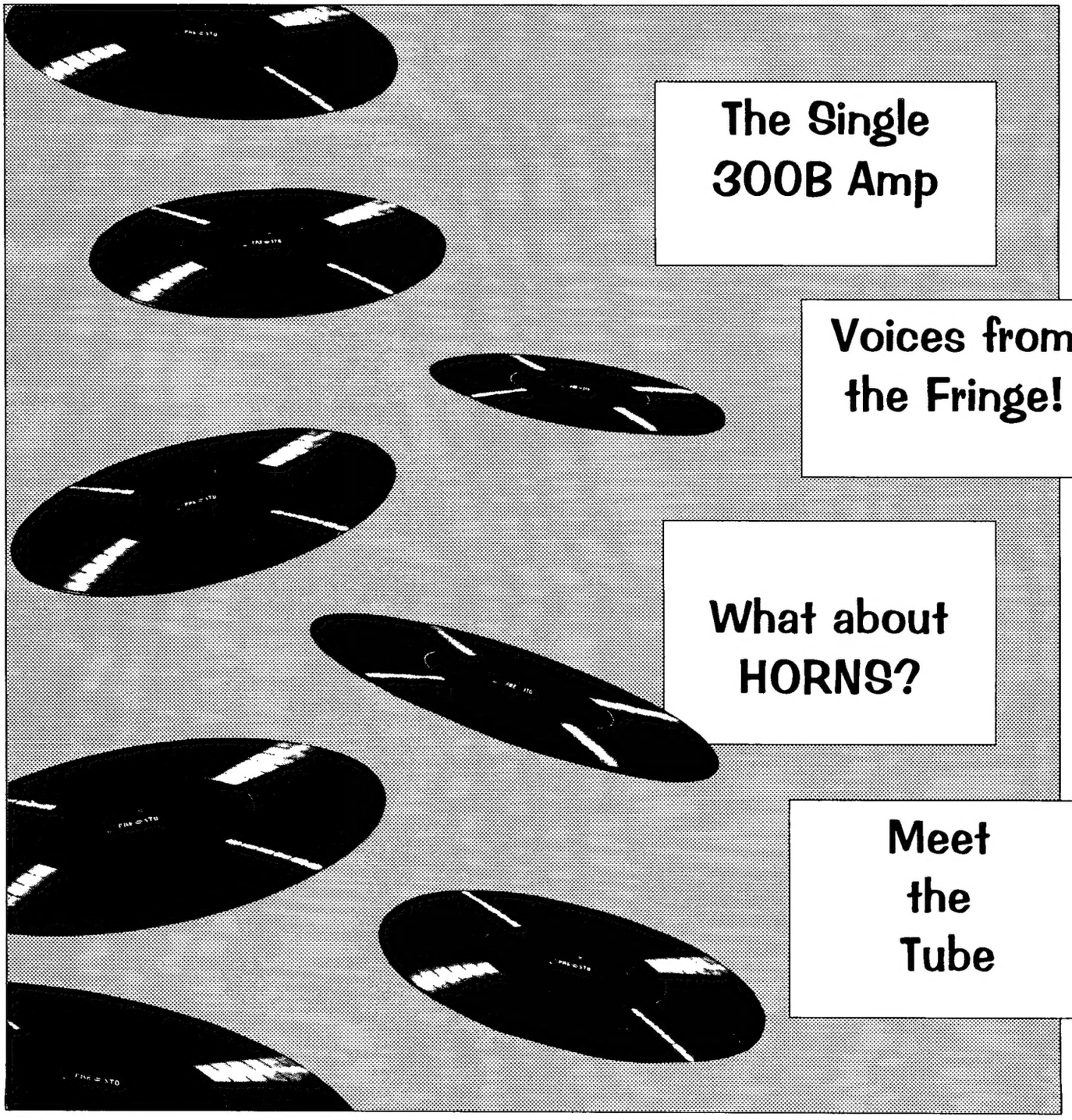
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SOUND PRACTICES

A JOURNAL OF AUDIO TECHNOLOGY SUMMER 1992



Variations of Audio Experience Issue #1

Sound Practices

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Voices from the Fringe?

Audio today consists of a much wider range of practice than you'll find reported in the glossy mags. Some of the most interesting activity in the hobby takes place outside the borders that commercial producers of contemporary equipment accept as their playing field. There are vintage gear enthusiasts, modifiers of old and new gear, and people who build things that the manufacturers are wise to avoid - products with limited popular appeal or which are not economically viable to manufacture. Except for Audio Amateur/Glass Audio, there's no dedicated forum for do-it-yourself audio, one of the most rewarding facets of our hobby. Only a few decades ago DIY was an important part of the hobby for people as committed to it as we are. What happened?

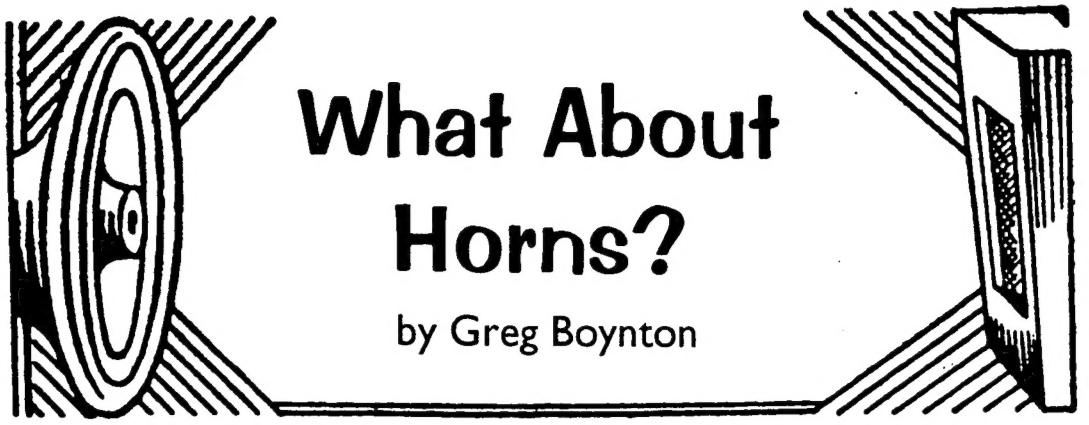
Since most magazines focus on the latest gear and currently fashionable technologies, any sense of the development of audio over the decades is lost. I consider the absence of historical perspective in the literature a very major failing. The development of the technology over the 80 years since the first useable tubes came along is a fascinating and important story which is too seldom told. And we would have a clearer understanding of present trends in audio (and other technology) if we study the past accomplishments of the ancestors and evaluate our practice in light of the technical and institutional factors which give it its present shape. Besides, some obsolete (and otherwise unfashionable) technologies can produce superb 1992 sound! Witness the current triode "revival".

My academic training is in anthropology not engineering. One of the main tenets of anthro is "relativism", the idea that one should keep an open mind about different ways of being. First you must consider what people themselves think they're doing, from *their* insider perspective, if you want to understand their actions. If you enter the worlds of sound engineers of the 1930's, Japanese horn speaker listeners, or contemporary high end designers you will meet some very smart people. The tools, technologies, and values are different, but there is a timelessness in the wisdom (and sometimes foolishness) of all sound practices.

Everyone who contributed to this issue is writing on a subject they get excited about. To get Sound Practices rolling, I wrote an article on one of my favorites, the single 300B amp. Then, I approached a few passionate, perceptive, and particularly adventurous audiophiles and asked them to write about what *they* believe needed to be said. I think you'll agree that there is an atypical group indeed gathered in the pages of our premiere issue. You would never read this stuff in *The Sensible Sound.* Voices from the fringe? Perhaps, but they say it with heart.

Lunatic fringe, DIYers, historians, and experimenters.There is a group of us looking beyond what is available in the glossy magazines. We know who we are and, as the old Spanish *aforismo* puts it, "We are not many but we know how to find each other." Maybe Sound Practices will be a place where we can meet and enjoy the benefits of the gathering.

Joe Roberts



What About Horns?

by Greg Boynton

Over the last 5 years, I have had the pleasure of exploring a branch of home speaker design that has been all but forgotten by the audio mainstream. The title of this article should give you a hint. Yep, that's right, HORNS! Oh my God you say, what is this person babbling about. Obsolete technology. Honky and distorted, right?

Wrong. I once held the opinion that horns were a kind of bad joke. People who used horns for speakers were either deaf or had a major case of tin ear. I now find myself in the somewhat awkward position of being a horn advocate. While bad horn systems are indeed unspeakably bad, a great one can be truly great.

Horn speakers fall into that category of products that includes vacuum tube amplifiers, vinyl records, and analogue tape recorders. These technologies were discarded primarily for reasons of convenience and profit margin. For the serious audiophile, the analogue record-tube electronics-horn speaker combination offers performance that leaves many CD -solid state amp - cone speaker systems in the dust.

Horn systems take up a lot of space but doing it right will also require time. To really get horns set up correctly will require a fair amount of thought and experimentation. You absolutely must get amplifiers which are compatible with the speakers. Biamplification (separate amps for high and low frequency drivers) is necessary to explore their full potential. It will require some effort on the part of the builder to acquire all necessary parts for the system. Finally, most horn system components (even the classy pro stuff) just don't cut it. You will have to choose your parts wisely.

But when you get a horn system set up right, the sound quality is amazing. The most obvious advantage is in the dynamic range and transient response of the horns. For me, the emotional impact of recorded music is in the dynamics. Most speakers just do not produce realistic dynamic contrasts. Horns do, and they do so with ease. They also excel in low distortion. The sound seems unusually clean even at high levels. Imaging quality ranges from adequate to outstanding, depending on the shape of the high frequency horn and the frequency extension of the driver. When I listen to my horn system, I find myself getting lost in the music, rather than in critiques of sound quality and technical arguments. That's the whole point.

SELECTING A HORN SYSTEM

Now that I've talked up horns, let me say that I'm not suggesting that you run out and buy one of the "classic" hi-fi speakers from the 1950's. Most of them make horrible compromises in design and are not worth the trouble. Particularly bad sounding horn speakers for the money include: any Klipsch product, RCA, EV Patricians, Georgians, etc., JBL Hartsfields (HA!), Altec 604s, any folded horn design, and any design in which time alignment of the drivers is impossible.

If you want a horn system, the best bet is to start with industrial equipment made by Altec, JBL, or Western Electric. Altec gear is the easiest to find and to work with. Aside from being reasonably common, Altec components are available at reasonable prices - a great system should cost less than $1000, much less if you're lucky. Also they made about the only workable low frequency cabinet for hi-fi use.

A two-way system is the easiest to build and set up. Also some of the best speaker components ever built were designed specifically for use in two-way systems. My favorites are the components designed by Jim Lansing (of JBL and Altec-Lansing fame) for Altec's famous "Voice of the Theater" systems. All of the VOT systems use similar cabinet designs but the size varies dramatically. Some of these babies weigh thousands of pounds. All VOT systems used the same drivers in various combinations. Typically they use 15" woofers and 1" or 1.4" high frequency compression drivers. The crossover point is typically in the 500 cycle range, giving each driver approximately 5 octaves to reproduce. The high frequency driver is fully horn loaded. The woofer is partially horn loaded with lower frequencies handled by a ported enclosure. The best known examples of this kind of speaker are the venerable Altec A5 and A7 VOT systems.

THE HIGH FREQUENCY HORN

Horn selection is probably the single most important challenge in constructing a high-fidelity horn system. Nearly all of the horns that were available from the major manufacturers sound dreadful. In putting together my system I listened to 12 different pairs of Altec horns, as well as some Electrovoice and JBL pieces. All of the horns were rated for use with a 500 cycle crossover. I can only conclude that sound quality just was not as important a design consideration as small size and dispersion control. Almost all of these horns exhibited large amounts of distortion at the crossover point and significant high frequency rolloff.

Most horns designed for theaters and auditoriums are meant to spread sound over a large area. Wide dispersion is not something which comes easily to horn speakers. Most designs rectify the directivity problem by sacrificing performance in other parameters. Such horns include multicellular, diffraction, and sectoral designs. All of them (well, most of them...) perform as designed. But, when the goal is ultimate fidelity, avoid them. Their sins are too numerous to list.

Instead, look for a horn with the following characteristics: First, you should be able to look straight into the mouth of the horn/driver combination and directly see the phase plug of the driver with no obstructions whatsoever. From the driver, the horn walls should follow a smooth curve as the horn opens out. Straight walls should be avoided if possible. Avoid radical changes in the cross-sectional shape of the horn. From

the driver through the throat, it should smoothly assume the shape of the horn mouth. The shape of the mouth is probably best kept close to a square or circle. Rectangular mouths with radial aspect ratios have the characteristics of diffraction horns and should be avoided.

In order for the horn to sound good through the crossover point it must be very long compared to most commercial designs. I would suggest at least 3 1/2 feet long for a 12 dB per octave crossover at 500 cycles. A somewhat shorter horn will work with an 18 dB or 24 dB per octave crossover. Shorter horns will tend to have severe intermodulation distortion and impedance problems around the crossover region.

Avoid any horns built of non-rigid materials like cardboard (no joke!). If the horn is constructed of a resonant material like cast aluminum or sheet steel, use some sort of deadening material like Mortite or lead sheet to control the resonance. Bolting the horn to a secure mount also helps. That's right, take all of those piles of old stereo magazines out from under it and bolt it down.

THE HIGH FREQUENCY DRIVER

There are several factors to consider in choosing a high frequency driver. The diaphragm material is important if wide frequency response is a goal. Aluminum, beryllium, and titanium are good. Only metal diaphragms are worthy of serious consideration. Phenolic diaphragms are best used in airport paging systems. Apologies to fans of old EV and RCA stuff but they just don't do it for me.

The phase plug is also important. The best system was used in the Western Electric, Altec, and JBL drivers. These units use concentric exponential flared slots through which the sound passes from the diaphragm to the throat. Again, avoid older EV drivers - now that the patent has run out EV uses the Lansing phase plug.

The magnetic system is also significant in its effects on both frequency response and driver distortion. heavy drivers generally sound better than light ones. This is because a large amount of iron is needed to carry the powerful magnetic fields which energize the voice coil gap. Try to get drivers with Alnico V magnets. These have inherently lower distortion than the ferrite crap they make nowadays. Pre WWII drivers often used

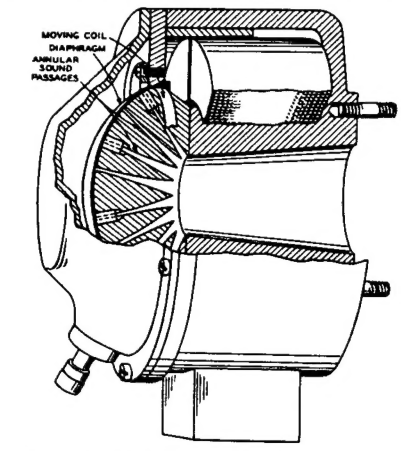


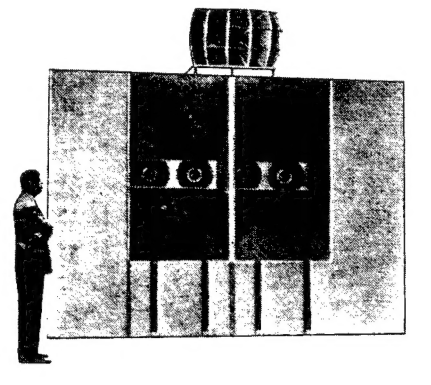
Fig. 3—Sound radiated by the diaphragm of the high-frequency units is conducted through concentric annular passages to prevent interference effects

Cutaway view of typical horn driver

powerful electromagnets and are worth checking out if you can find them.

THE LOW FREQUENCY ENCLOSURE

Low frequency horns require lots of space. To actually get even 50 cycle tones out of a horn it must be *huge*. In some installations people have built straight exponential bass horns. A system of this size would take up my whole house. The best compromise is to partially horn load the bass. This requires an enclosure which is both a short horn and a tuned port. The short horn is not compression driven like the high frequency section. It's really more of a directional baffle. It serves two purposes: the woofer cone is recessed into the enclosure facilitating the alignment of high and low frequency drivers and the dispersion of the woofer at the middle frequencies is narrowed making a more natural transition to the narrow dispersion high frequency horn. Altec used this system almost exclusively in "Voice of the Theater" installations.



The Altec A-2: A large VOT system

For most people, buying the cabinet is a smarter move than building one. Construction of the wooden horn parts is best left to those with serious woodworking experience. I built Altec A7 type cabinets and it was no fun at all. An interesting and convenient alternative is to buy one of the modern public address cabinets. Community Light and Sound makes a cool thing called a VB790 which is a fiberglass version of the Altec vented horn type enclosure. To build it you buy the fiberglass horn from CLS and construct a nice rectangular box. The flare bolts in with no hassle. But, I imagine most of you are hung up on having the original kind of thing. In that case, buy the Altec 3/4" or 5/8" plywood cabinets that were part of the A5 or A7 systems.

The A5 and A7 cabinets are fairly common since they were the mainstays of the VOT line. If you have the space, one of the larger VOT cabinets would provide better low frequency performance. For most of us, practical considerations dictate a smaller system

LOW FREQUENCY DRIVERS

There are a lot of good choices for a low frequency loudspeaker. I have listened to units from Altec, Electrovoice, JBL, Jensen, and Stephens. The quality of bass note tracing some of these units can produce when properly horn loaded is amazing. Woofer design has not really improved for quite a while. Many of the older units are unsurpassed in performance.

Most modern woofers offer reduced efficiency and greater power handling capability. I have seen this trend quite clearly in the sound industry. JBL now makes 15" woofers that handle 800 watts. Compared to the 15" units made even 30 years ago these monsters don't sound as good. Power handling means heat dissipation, which means more weight. The voice coil gets heavier, the coil former gets heavier. The suspension of the driver has to be strengthened to withstand those 800 watt excursions. If you want to know how this makes a speaker sound, just tape a big rock to the cone of your favorite speaker (or listen to some of the leading planar speakers).

When looking for a woofer, try to find one with a big Alnico magnet. Alnico has efficiency and distortion advantages over ferrite and ceramic magnets. Another desirable feature is an edgewound voice coil. This geometry gets more wire into the gap, promoting high efficiency. The voice coil

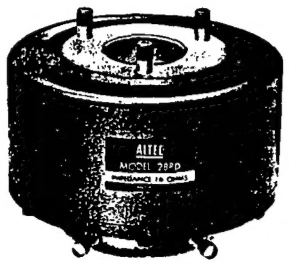
Recommended ALTEC Components

HORNS

Finding a good horn is the key to building a great system. Unfortunately, the good horns are few. Some horns require "throats" or adaptors to mate with your driver. Try to get these when you get your horn if you need them. They can be expensive or hard to find as spare parts. A crossover no lower than 500 cycles is recommended with these nominally 300 cycle horns.

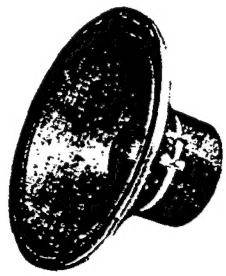
Here are a few horns that worked for me. These are subjective impressions and somewhat surprising in light of Altec's intended applications. Among common and reasonably proportioned Altec units, the 311-60 and the 311-90 are your best bet. Surprisingly good sounding despite their rather cheapo cast construction - apply damping to exterior. A 288 bolts right on. The sheet metal 203 is a nice long two cell horn which avoids many of the problems presented by shorter horns with more cells in the home listening context. Intended as a "long throw" horn but sounds good short range. The Altec horn that works best in my system is the large cast aluminum 329A. It is rather unhandy to install but it sure sounds good.

Perhaps the best option is to build the right kind of horn from scratch. Simple equations for horn design can be found in *Audio* magazine articles fron the '50s and a number of textbooks. Use of Altec hardware and throats can facilitate the mechanical interface with your driver. I'm working on this project myself - results forthcoming in a future installment.



288 Driver

Power	40 Watts (above 500 cycles)
Frequency	500-16,000 cps
SPL	115 dB at 1 W / 131 dB at 40 W
Impedance	16 Ohms
Weight	20 pounds



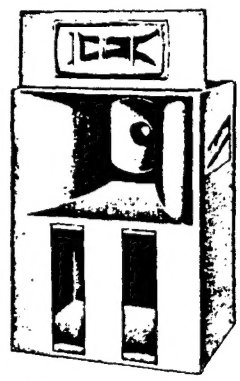
515 Loudspeaker

Power	35 Watts (50 W. Peak)
Impedance	16 Ohms
Diameter	15 3/16"
Mounting hole	13 1/4"
Weight	26 pounds

LOW FREQUENCY HORNS

These enclosures are direct radiating exponential horns using a modified bass reflex principle and are the proper enclosure for the 515 or 803A loudspeaker in full range two-way public address systems.

	HEIGHT	WIDTH with wings	WIDTH without wings	DEPTH	NET WEIGHT
110 with stand	87"	73¼"	50"	35½"	400 lbs.
210	84"	80½"	32½"	39½"	560 lbs.
410	84"	103"	65"	39½"	890 lbs.
610	84"	135½"	97½"	39½"	1220 lbs.
825	42"		30"	24"	100 lbs.



825 Cabinet

formers on the better speakers are paper. A heavy aluminum former just reduces the quality of the sound. Besides, we're only going to be running maybe 50 watts max on the system, so who cares about 800 watt power handling?

As far as cone material is concerned, paper is *it*. The combination of a light paper cone and a big magnet is difficult to beat. Harder stock usually provides more detailed reproduction through the midbass. The shape of the cone can be important. Straight wall cones have better tone and detail through the mid bass and curved wall cones have better top end extension. With a 500 cycle X-over, straight wall cones are preferable.

Woofer suspensions also have a great effect on sound quality. In high efficiency speakers there is little coil overhang in the gap. The coil must be returned to the exact center of its travel. If this doesn't happen, the sound is muddied because of asymmetry in the magnetic field. I like the old Lansing spiders which are made of Bakelite. They hold the cone in a rigid grip and provide for controlled excursion. In a proper enclosure, total cone travel is only a small fraction of an inch so excursion limiting is no problem.

The most common really great old woofer is the Altec 515 or 515A. It was in production for about 40 years beginning in the mid-40s. The older ones used bakelite spiders and a straight walled cone of hard stock with a half-rolled paper surround. This is how speakers should be built. The later 515 is the B model. During the 1980's this speaker was made with a ferrrite magnet which is clearly inferior to the awesome Alnico magnet of its forebearers.

Other woofers worth checking out are the Altec 416 and 803. The 416 is a late 803 with a different part number. The 803 is similar to the 515 but designed for use with an 800 cycle crossover. The 803 woofer with the 825 cabinet, the 803 compression driver, and the 811 horn made up Altec's A7. This was the "baby" VOT.

CROSSOVERS

As is the case with horns, most crossover designs of the early days are not really that good for hi-fi use. One of the biggest problems can be solved by using very long horns. The reason that horn length can affect crossover performance so dramatically is

(continued on p. 21)

HORNS (continued from p.4)

because crossovers are directly affected by impedance changes in the drivers. If a horn is too short for a given frequency to be reproduced the speaker will present a far different load to the crossover than its nominal 16 or whatever ohms. Crossover networks require a flat impedance curve for the high and low frequency drivers to sum properly. Impedance changes result in phase and amplitude anomalies.

Be sure to take pains to phase your speakers correctly. You will have to experiment because drivers are not all phased the same electrically. Go for the connection which produces the most output at the crossover point. Get a friend to switch the connections while you listen. Make sure the drivers are aligned such that the ear-speaker distance is the same for each driver.

Because of the complicated nature of crossover design, I am inclined to gloss over it in this introductory article. In a follow-up piece, I will provide tips for bringing old crossovers in line with modern practice and a design for a high quality line level crossover for a biamp application that will really get those old drivers working. Stay tuned.

One of the major challenges in setting up a horn system is finding an amplifier which will work with the horns. High power solid state amplifiers sound best when mated to inefficient speakers. With horn speakers they tend to sound really awful. The efficiency of horns is so high that your average big hog solid state amp never really gets turned on. Likewise, big tube amps using banks of 6550s just don't sound that clean when operated in the milliwatt power range. Horns work best with *low power* tube amps.

I hope this introductory survey will help some experimenters avoid a few of the most tempting wrong turns. Most of the information you really need to know will not be found in any books. Good "pro" sound practice differs from the best strategy for hi-fi horns in the home. Some suggestions you read here would be a mistake in the theater context. But recognize that what excels in the auditorium won't necessarily soar in your listening room and you're on your way.

Greg Boynton is proprietor of Rapid Sound, provider of audiophile quality sound reinforcement and audio consulting for the Grand Rapids, MI area.

THE SINGLE 300B AMPLIFIER: A MODEL 91 FOR 1992

BY JOE ROBERTS

Back in the 1930's, the American public had its first experience of wide range audio in the movie theaters. By then, radios and 78 players were common in the home so the initial amazement at "talking boxes" had worn off somewhat. The '30s radio probably sounded okay for tuning in Will Rogers but the movie palace was the home of the first real audio goosebumps.

Back then, audio was at the forefront of engineering and major companies invested heavily in research and development of this young and potentially lucrative technology. The movie theater was an arena for heavy competition among major players in the electronics and communications industry. After all, there was big money in outfitting Hollywood and the tens of thousands of sound theaters nationwide and abroad. American industry rose to the task.

A lot of our basic knowledge about sound and perception came out of the institutional research context created by these huge corporations. The insights gained by well-financed "men of science" in audio research enriched lives not only through moving pictures but also by improvements in telecommunication systems and the information industry in general.

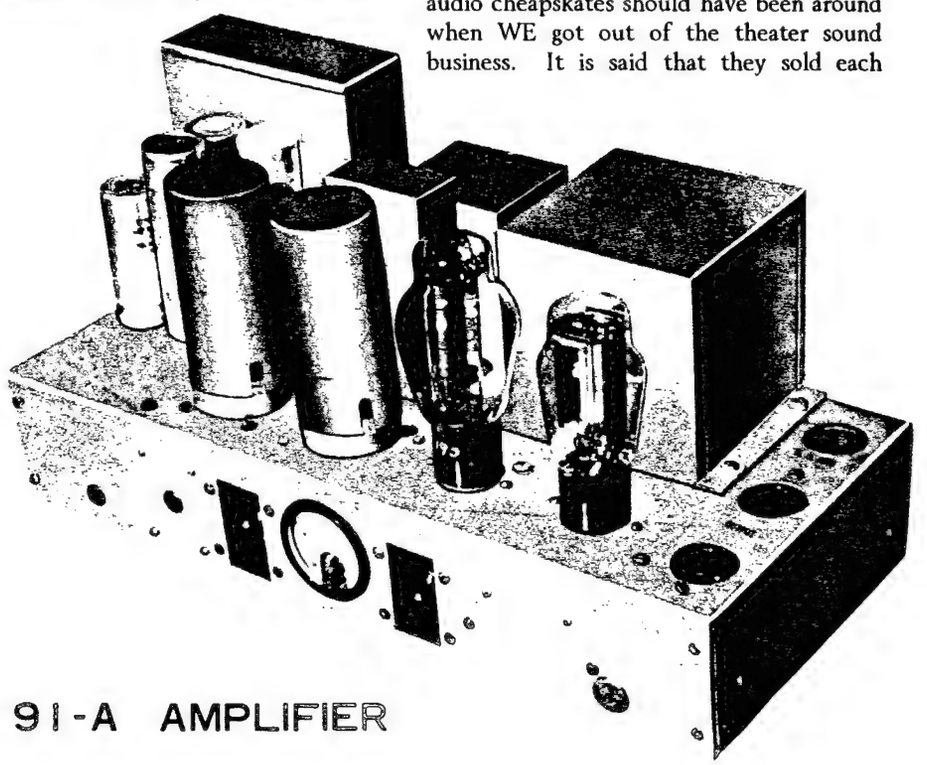
RCA (Photophone) and Western Electric (Mirrophonic) were the two dominant forces in the emergent theater sound market back in the 30's. Both developed complete systems for recording and playback of cinema sound, from the microphones on the set to the speakers on the stage. You can do historical research on this topic while watching old movies on TV. Look on the credits for RCA or Western Electric logos. I must admit that I enjoy Popeye cartoons much more knowing they were produced with WECO Mirrophonic equipment.

Today, theater gear of the golden era, particularly Western Electric Mirrophonic equipment, is revered by aficionados of vintage audio worldwide. A complete stereo set of WE amps and speakers would cost as much as a new car - if you could find it. It would cost many hundreds to ship. A large slice of the street price of Mirrophonic gear can be attributed to its status as rare, desirable collectible. Certainly this system has enormous significance in the technical and social history of audio technology. But make no mistake about it, this equipment is capable of stunning sonics and it is highly sought after for this reason as well as its artifact value.

Typical theater systems of the era employed very low power amps by today's measure and enormous super-efficient horn loaded speaker systems. Often these speakers used electrodynamic drivers since field coils provided higher flux for the bucks than permanent magnets in those days. Ten watts was enough to fill a good sized movie house to impressive SPLs. Nowadays the equation is reversed; you need 100 watts to drive a one cubic foot mini monitor to acceptable living room levels. Anyway, it's clear that the efficient old methods were in sync with the laws of physics. Must be nice to have a theater sized listening room to indulge mother nature.

Two WE amplifiers were featured in the Mirrophonic systems, the Model 86 and the Model 91. The 86 is a push pull 15 watt all triode amp using 3 WE 262 tubes as single-ended voltage amplifiers transformer coupled to a pair of WE 300Bs at the output. The 91 is a single ended 300B amplifier, good for 1/2 the output of the 86, which uses two WE 310A pentodes in voltage amplifier stages. Both amps were high gain devices (>95 dB) intended to amplify the low output signal of a photoelectric sound cell in the projector. The 86 and 91 were specialized instruments meant to be used in Mirrophonic theater systems and their industrial strength looks tell the tale.

The 91 can be viewed as the economy model Mirrophonic amp. It uses a lot less iron (no interstage trans. or choke) and surely was less expensive to make. By the way, WE didn't sell this stuff - they *leased* it to theaters the same way Ma Bell used to lease you your phone. By 1992, the prices on the 86 and 92 have evened out somewhat. You audio cheapskates should have been around when WE got out of the theater sound business. It is said that they sold each



91-A AMPLIFIER

installed system to a lucky theater owner for $1 to close out the existing leases!

The published specifications of the 91 are rather unimpressive by today's standards. The data sheet on the 91 claims a useable range of 50 to 8000 cycles at 8 watts with distortion figures in the single numbers. These ratings are conservative but you can do you can do a little better than this with a LM 383 chip for a couple bucks. As is so often the case the specs don't begin to tell the whole story. The 91 plays with incredible authority on appropriate speakers. Liquid, detailed, natural and harmonically right on - rich but not too slow - it is a majestic and utterly involving presentation. The chip provides acceptable AM car radio performance.

If you plan to begin looking for a Mirrophonic system, Tokyo would be a good place to start. The Japanese obsession with Western Electric gear is well known and often satirized by US audiophiles. Based on my listening, I wouldn't be too quick to judge. Not only are *certain* WE amps amazingly good but *some* WE horn drivers and cone speakers are also exceptional. I must applaud the Japanese for recognizing the virtues of Western Electric even if they sometimes get a bit carried away with brand name worship. Audio is one activity in which it's cool to be crazy in Japan.

The fact is that not all WECO gear is audiophile manna from on high. Some of their products are meant for BINGO hall grade applications and they sound it. On the other hand, some "general purpose" WE amps and speakers were used everywhere from radio stations and studios to Woolworth's and school PA systems. At one time, my home system consisted of Model 124 amps (12 watt push-pull 6L6) from a shoe store in Michigan and 755A speakers that came out of the ceiling of a think tank in Cambridge, MA. It was difficult to admit this to my clients at Excalibur Audio (now defunct) while trying to sell $1000 cables. Funny that I thought my system sounded better than a lot of stuff in the store!

I first heard about WE from local audiophiles who were active in the early 50's. When anti-trust proceedings forced WE out of the sound equipment trade in the late 40's, surplus permanent magnet WE speakers dumped on the market were snatched up by "golden ear" types at bargain rates; you can see 'em in Harvey Radio ads from the early 50's. Electrodynamic WECO theater speakers were also highly revered by early Hi-Fi experimenters. The first Klipschhorns in 1948/9 used WE compression drivers, possibly obtained through surplus channels. Avery Fisher used electrodynamic WE theater speakers at home. Surely, Mr. Fisher could afford to choose the best.

As a student of Western Electric, Walt Bender of *Audiomart*, wrote in TAS 54, perhaps it is a limitation of the American ethos that the latest is often unthinkingly considered the greatest. Some very experienced listeners solemnly contend that WE gear blows just about everything else away. Naturally, any such pronouncement should be recognized as a strong statement of taste rather than "truth" in any empirically verifiable sense. Even those "true believers" usually admit to shock when they discovered that this industrial looking stuff outperforms Mac, Marantz, and most other products since!

Western Electric ranks high among the giants of audio. And the Model 91 is one of WECOs most intriguing and best sounding designs. If you are at all intrigued with single triode amplifiers, as historical artifact or as contemporary strategy for good sound, study the Model 91 because it defines the genre.

THE SINGLE 300B AMP

In many areas of the world, the allure of the single triode amp lives on. It is certainly not a mainstream audio phenomenon anywhere but numerous single 300B amps are available as kits and off-the-shelf product in Japan and Europe. If you read (or look at the pictures) in Revue du Son, L'Audiophile, or any of the Japanese audio mags, you will see ads for the single 300B.

The 300B has attracted quite an aura of mystique over the years. It was first announced in Bell Laboratories Record in 1935 in the form of the 300A. The difference between the A and B was that the guide pin on the side of the base was rotated a few degrees. The 300A/B was designed as a replacement for large transmitting triodes in audio service, offering higher output at lower plate and filament voltages.

There is no direct substitute for this filimentary cathode tube. It is generally similar to the earlier RCA 50 in characteristics, with the exception of filament voltage, but it is considerably improved in terms of mechanical construction and life characteristics. It is a real workhorse.

The 300B was primarily intended for audio use but they you occasionally find them in regulated power supplies (what a waste). Only a few WE amps used 300Bs - the 86, 91, 92, and some versions of the 46. .As far as I am aware, the only classic consumer amp that could be set up for 300Bs was the Brook 10C, which had a filament transformer with 2.5 V taps for 2A3s and 5V for the 300B.

Since original WECO 91's are in short supply everywhere and tough to get running in a home system, the single 300B amp is an international favorite with audio constructors. Transformers for the single 300B application are produced by Partridge, Tango, Tamura, and various other companies in Japan. A small niche industry has developed behind this amp in pockets around the globe.

Finally, nearly almost 60 years after its debut, it seems that the single 300B amplifier is coming home. Cary Audio is producing a single 300B amp and Mike LaFevre at MagneQuest/Peerless is reproducing old designs and developing new iron for this legendary tube in his Philadelphia workshop. Suddenly, the concept of running an amp with a single digit power rating is an exciting proposition for some adventurous audiophiles.

Perhaps, it's an extension of the "rebirth of the triode" we have been experiencing in contemporary US high end with manufacturers like VTL, ARC, et.al. venturing into triode amp products. As we go to press, *The Absolute Sound (Issue 79)* features the $67,000 Onagku single 211 amp ! What next?

Fact is that until recently triode amps haven't been a real option for audiophiles since the early '50s when the Brook amps, Fisher 50A, and Craftsmen 500 were among leading contenders. Even at that early date, triode output stages were specialist items for extremists. Brook amps were among the few that used real (three element) triode tubes, i.e. 2A3 or 300B. Others included the Bell 2145, Sun Radio CR-10, and the Goodall ATB-3 which could use either triodes or 6L6s - all of which were based on the 6B4-G, a 6.3V octal version of the venerable 2A3.

Most "triode" amps, then as now, used triode wired KT66, EL37s, or similar beefy beam power tubes to get the extra watts which such tubes provide in triode operation. As you Marantz groupies will be quick to note, the 8B offered the option of triode configuration by tying the screen to the plate through a 100 ohm resistor.

The hard fact is that despite their technical and sonic virtues, triodes just don't deliver high power for the buck and power is easy to sell. You can get double the power from a pentode for the same manufacturing dollar. Just as manufacturing economics drove the market toward transistors around 1960, the triode was pushed out back in the mid-thirties by the pentode. Single-ended amps were an early casualty in the specs and power war, except in the most uncritical applications - TV sets, table radios, etc. - and in pentode powered guitar amps designed to distort.

Better specs (or more power) per dollar is the death sentence of last year's technology. Manufacturing economics drives the market. Subjective concerns, which matter only to "freaks" like us, have little influence on the big picture.

Contemporary high end audio moves outside the usual strict economic constraints to some extent, but it must operate within a larger supply and support context which is very susceptible to changes in mass market practice. In 1960, you could buy 6550s at the local drugstore. Output transformers, no problem. Probably a few places in town that sold 'em. Who would argue that tubes and related parts are better today than back when billions were spent annually on tube equipment? It's a challenge to pursue state of the art in an obsolescent technology and the quality of the support apparatus may set the limits of what is possible with tubes today.

Parts for the single 300B amp are available all over the world from specialist suppliers, but since it won't support "economies of scale", nowhere is the 300B amplifier an "audio cheapskate" pursuit. New WE 300Bs go for upwards of $200 in this country. A set of worthy transformers of modern manufacture will cost several hundred more. Looking on the bright side, you can build a pair of single 300B amps to a high standard for a bit over a thousand dollars and still save thousands over a pair of genuine WE 91s. Be thankful that the amp only uses one tube per side!

Forget the price tag - moderate by high end standards anyway - unless you're shopping for watts per dollar. The 300B is hard to beat in terms of midrange glory and it gives you a fair power output for a single tube. For the price of a decent "upper mid-fi" set-up, you can have the best 8W amps in town.

The single 300B amp is a great beginner project for several reasons - simple design with low parts population, no need to match parts and tubes, no balancing or adjustment necessary - just check the voltages and fire it up. Of course the usual challenge of parts procurement applies but most of the components are standard stuff. I know several hobbyists who never built before who have constructed single 300B amps with success. The lure of the 300B is a powerful force, transforming passive "Recommended Component List" zombies into intrepid experimenters.

Basically, if you want to hear a single 300B amp, you almost have to build it yourself-that's why I built mine. There's a motivational factor lacking for push pull pentode projects! I would be sure be less enthusiastic about spending three weeks in the basement working on a scratch built Stereo 70.

THE WECO 91

The original Model 91 is built with reliability and serviceability in mind. You don't want the system going down in the middle of "Gone with the Wind" with a full house. The amp is built on a heavy welded chassis and all wiring is cleanly bundled and laced. Electrolytic caps are screw base types for easy field replacement. Coupling caps are hermetically sealed oil types of WE manufacture. All signal resistors are 2 watt Allen Bradley composition type and power resistors are hefty ceramic wirewounds. Plate current in the driver and output tubes is metered. Western Electric, the manufacturing arm of the Bell System, understood reliability and maintainability. Remember those bomb-proof black WE dial phones?

Setting up a WE 91 in your home audio system is not straightforward. Inputs and outputs use unusual 5 and 6 pin tube socket like connectors. The field coil of a monitor speaker in the projection booth served as a power supply choke (see schematic) in Mirrophonic installations. Since you're not using this speaker, you'll have to outboard a choke (it won't fit underneath) and you need a high DC resistance inductor (maybe 1K ohms) to get the voltages right. Nowhere to put it. A real hassle.

The standard input is 30 ohms balanced, but this isn't an obstacle since for home use the first stage can be disconnected and the signal fed to the grid of the second 310A. One voltage amp stage is all you need with a line level source. In the 91s I set up for home systems, I just disconnect the feedback resistor and let the amp run open loop. Another method is to replace the input trans with a volume pot and strap out one of the feedback resistors to decrease closed loop gain. In this configuration both 310A stages are used.

As you might expect, a 50+ year old amp usually requires a bit of restoration to get it back in the game. Resistors drift, cloth insulated wire disintegrates, impossible to find 500V screwbase caps give up, etc. Breaks. your heart to conduct major surgery on such a classic.

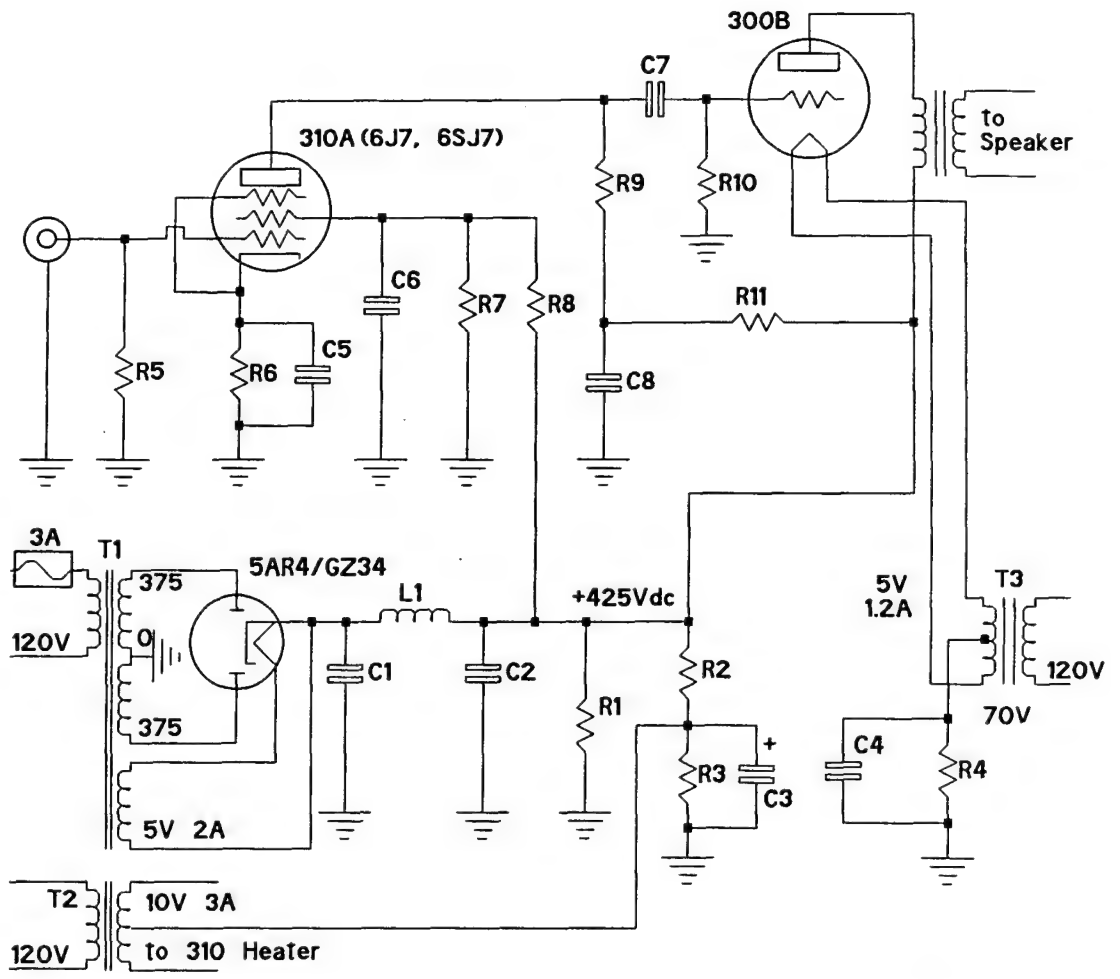
The heck with it I say. Let's just build one from scratch. Actually it is possible to recreate the 91 circuit in a more appropriate form with real RCA jacks and speaker terminals, using fresh parts, and including only the required voltage amp stage. The aural magic will still be there. In fact, in a side by side comparison, I preferred my homebrew to the original after I tweaked my creation to taste. Since you're flying the soldering iron, you can customize the look and sound of your "mock 91" to suit your eye and ear.

BUILDING YOUR CUSTOM 91

Figure 2 shows a circuit which you can use to build an amplifier patterned after the WE 91. This "abbreviated 91" is a very popular design in Japan and France. It is *the* classic single 300B circuit. There is an undeniable synergy in the 310 + 300B recipe, a perennial favorite among triode amp enthusiasts.

Basically, this circuit recreates the modifications necessary to civilize a WE 91 for home use. The first 310 stage and the feedback loop are left out. A choke is included in the power supply as standard equipment and RCA jacks and manageable speaker terminals are furnished.

I chose to build my amp using classic parts for both philosophical and sonic reasons. Resistors are 2 watt Allen Bradley composition or wirewound ceramic power types of



12/93 corrected version

R1 - 50K 25W wirewound	R8 - 75K 5W wirewound	C1-C2 - 15 mf 1000V oil cap (or 2 X 8 uf in parallel). Use 500V electrolytics if you insist on being conventional.	C6 - film or oil cap 8 mf 200V
R2 - 270K 2W	R9 - 91K 2W	C3 - 50mf 100V electrolytic	C7 - .1mf 600V Vitamin Q
R3 - 20K 2W	R10 - 390K 2W	C4 -C5 - 16 mf oil cap or film bypass cap of your choice @ 75VDC or greater.	C8 - 15 mf 1000V oil cap
R4 - 880 ohm 50 W. wire wound	R11 - 27K 10W wirewound		T1 - 375-0-375 V @ 125 ma; 5V@ 2A
R5 - 220K 2W	All 2W resistors Allen Bradley composition type 5% tol. or "tweak" resistor of your choice.		T2 - 10V @ 500ma CT
R6 - 1.2K 2W			T3 - 5V @ 1.2A CT
R7 - 30K 5W wirewound			L1 - 10 henry 125 ma choke

appropriate wattage. PCB caps made before OSHA regulations improved worker's lives at the expense of capacitor technology are employed liberally throughout. Power components are mil-spec surplus iron or commercial units of high quality. I usually build my amps on heavy Bud box style chassis for that timeless "made in the garage" look - a surefire spouse pleaser.

I heartily recommend auditioning various components in your homebrew projects. After all you're building it so look for a sound that makes your ears happy. You will find that this amplifier is highly sensitive to parts swapping and it's a low parts count design so it's a good test bench for experimentation. The beauty of "rolling your own" is that you can optimize the aural character of your creation to fit your tastes and system balance.

You might feel inclined to go with the times and use the standard metal film resistors but I would recommend giving those forgotten ultramusical AB carbon composition resistors a second listen in this circuit. Like most triode designs, this amp is so subjectively quiet that the added noise of a high quality composition resistor, minimal in any case, still results in a lower junk level than most listeners are used to. I personally don't care much for the icy and sharp sound of metal film resistors but if you like it, go for it. At least make sure that's what you actually like by trying other kinds.

After auditioning various film caps and electrolytics at various points of the circuit, I

chose to use a Vitamin Q 196P oil impregnated paper cap for coupling and Sprague Clorinol oil caps shunted with .1 mf polystyrenes for cathode bypass. If you never listened to a good oil cap in your audio chain you might be really surprised when you do. They produce an extremely liquid and grainless sound which might be just what you've been looking for. All the detail is there but it is integrated in a different, what I perceive as a more natural, way than with film caps. They are also historically correct in a circuit of '30's vintage. Other constructors report good results using Teflon caps, Vishay resistors, and other modern "tweak" parts. The best cap for your application will depend on your output transformer, speakers, and individual taste. Try as many as possible.

I chose to use bypass cap values close to those specified in the original WE design. I was unconcerned about low end rolloff since my system bandwidth is limited by my speakers and the -3db @ 12 Hz rolloff provided by 15uf cathode bypass caps exceed the capabilities of the output transformers at my disposal by >20 Hz. Besides, a good sounding 100mf cap is hard to find.

POWER SUPPLY

The power supply is a standard full wave rectifier, cap input circuit with no surprises. It is a good idea to use a slow turn on rectifier like the WE274B or a 5AR4/GZ34 so you don't blast your priceless 300Bs with B+ before the filaments warm up. Based on my listening, I would say that the GZ34 gets the nod on sonics. Very smooth and musical. The 274B provides a bit leaner tonal balance but I find both Sylvania and WE 274B to impart a slight glassy effect to the musical presentation. I have no theoretical explanation for "rectifier sound" so I look forward to hearing from you if you do. Not just a question of voltage drop, scope jockeys. Be aware that rectifiers do sound different so audition several types as part of the general process of parts selection.

I used 15 mf @ 1000V oil caps in the power supply for reliability as well as sonic considerations. You could also use electrolytic caps but I like the smooth sound of oil caps. If you opt for electrolytics try a single 4-10 mf oil cap across the second cap in the pi network(C2) and listen to the grain disappear.

This is a pure class A design so the power supply doesn't have to cope with large peaks in current demand. Thus here is an opportunity to go with quality over quantity in filter caps in good conscience. With two 15 mf caps and a10 Henry choke, ripple is reduced to .03% or thereabouts. Use a bleeder resistor to improve regulation, prevent overvoltage at turn on, and provide a discharge path for the filter caps as a safety measure. A good oil cap will hold a dangerous charge for a long time!

You don't see too many oil caps in audio gear, especially at the consumer level. Marantz used them as the input filter cap in the Model 2. Some Altec pro amps also used them for filter caps. The problem is not performance but price. Back in 1952, when a three section 40 mf @450V electrolytic cost $4.90, 10mf 600V oil caps ran $15.85 each. All manufacturers have to be concerned with runaway costs. When you build your own you can use better parts than would be found in anything you can buy off the rack.

THE 310A/B STAGE

The 310A is a 10 V filament, six pin base pentode which has a grid connection via a cap on the top of the tube. It is a general purpose pentode, akin to the later octal 6J7 or 6SJ7 which will work just fine in this circuit The octal WE version of the 310 is the WE 348A. There was also a 310B which was controlled for low hum and microphonics, targeted for low level preamp applications. A standard 310A is quiet enough for this application. The 310A was designed for critical carrier amplifier service in the telephone system. The phone company ran 310s on DC filament supplies and a DC supply for the tube would be a nice touch. Noise should not be a problem with an AC supply.

There are some parts required to install the 310A. The grid cap is the same size as that on an 807. If you don't want to bother with finding or installing a 10V filament transformer or if your power trans has a 6.3V winding, you can substitute a WE 328A which is essentially the same tube with a 6.3 V filament. A 6J7 (or 348A) will require a smaller grid connector which is often a bare metal spring clip. The exposed terminal is a grid so there is no problem with dangerous voltages.

You will want to use a shielded cable running up to the grid cap with the braid grounded to the chassis. A piece of interconnect will fit the bill. I put +40 volts on the filament line through a voltage divider from B+ to avoid potential hum problems.

I would recommend using a poly or oil cap to bypass the cathode resistor. If you choose to use electrolytic caps here, try paralleling them with a cap of high sonic integrity. I found that the screen bypass cap had a strong effect on bass quality and I recommend experimentation to find the one you like. An electrolytic will work, I guess, but why skimp in such a classic design. I ultimately chose a Aerovox 12mf glass seal metal case paper cap. Maybe a large poly cap like a Solen will do the job for you. Use what you can get but don't settle for junk.

THE 300B STAGE

You'll need a 5 volt filament transformer for the 300B. Try to find one with a center tapped secondary. You can then run the 880 ohm cathode resistor from center tap to ground like WE did and apply the bias voltage through the filament transformer winding. In this arrangement, the signal doesn't have to go through a big ugly wirewound pot. In the amps I built there was no need for a hum balancing pot at the filament.

If you can't find a center tapped xfmr or if you discover that you need hum balance capability connect the bias resistor to the wiper of a 25 ohm 50 watt pot and connect the remaining terminals to the filament connections of the 300B. If you twist all filament leads, and locate the 310A away from power supply iron there should be no hum problems. In a single ended amp you don't get the common mode rejection provided by a push pull configuration so take all applicable precautions.

880 ohms is not a standard value but I found Ohmite Brown Devils in this value so they were made. MCM Electronics has 870 ohm 25 W rectangular cement resistors - they will work fine but you'll need to wire four in series parallel to get adequate power handling capability, i.e. connect four leads then connect the remaining leads in sets of two. Maintain our usual high standards in cathode bypass cap selection.

Be sure to check the filament voltage and add dropping resistors if it is too high - you don't want to roast this tube! High filament voltage is one of the leading cause of early demise in vacuum tubes. I would shoot for 4.8-5 V RMS measured with the tube plugged in.

Speaking of 300Bs, there are several brands on the market these days. Genuine Western Electrics seem to be the most desirable and are priced accordingly. The last genuine WE 300B tube rolled off the assembly line in 1988. It was the last tube that WE made and it had been in constant production for 53 years! The quality control and life expectancy of the original Western Electric tube is exceptional. At 10000 hours lifespan, figure on paying 2 cents per tube per hour of musical bliss. I have not tried any of the Cetron or Golden Dragon tubes. Ask around for opinions on these if you're tempted. You can't go wrong with the WE version. Take note that the WE version sells for considerably more than the others, possibly with good reason.

OUTPUT TRANSFORMERS

The other challenge in building a 91 lies in procuring a quality single ended output transformer. They sure don't sell em at K Mart. Luckily, the situation for American audiophiles is improving. Peerless is recreating the Altec TFA-204 which was a replacement part for the Altec version of the 91 [Altec started as a service division of WECO-All Technical Services]. There is also a new design single 300B transformer in the works from Peerless. The Partridge is an old standby among European and Japanese constructors but it is not available stateside. Tango of Japan makes some iron suitable for the single 300B and these are trickling in.

What is special about single ended transformers is that they employ an air gap so that the core will not saturate in the presence of a heavy DC Magnetizing current, i.e. the plate current of the 300B, flowing through the primary. I'm no transformer design whiz but the concept is similar to the air gap between the winding and the core of a filter choke which forestall saturation of the core. According to those who would know, designing a good wide bandwidth single ended trans is an order of magnitude more difficult than developing a good push pull transformer due to the issue of unbalanced DC.

I am fortunate to have had the opportunity to hear several transformers on my single 300B amps. Most of my listening was done using WE 755s (8" full range 70-13,000 hz response) in a slant front 2 cubic ft. cabinet, Thorens TD-124/SME3009/Grado MCZ, homebrew preamp playing Dinah Washington, Patsy Cline, 50's Jazz and other stuff I play for musical enjoyment. I realize that this is a non standard reference system, but this ain't Sea Cliff, fellas.

Anyway, I'll try to provide a subjective & unscientific survey of the iron to shed some illumination on the field. Take it for what it's worth. There are various other transformers available in the Japanese market from Lux, Tamura, and others. Never had the opportunity to hear them. Let us all know what you think if you have.

Original WE 171A- Great midrange texture, slightly soft on the top end. Romantic, luscious and involving. Very forward soundstage. Speaker really seemed to couple to the room with this transformer. Impossible to find, unfortunately. I wouldn't even bother trying.

Peerless TFA-204 - This trans was designed by Altec as a 91 replacement part. They probably didn't want low bass in theater sound to avoid low frequency flutter. Good choice to drive the mids/highs in a multi-amp system if you want a modern 'neutral' sound but not the best bet for systems capable of impressive bass. Clean, fast, high definition sound. Accurate but musical. Unfortunately, limited bandwidth rules it out for full range use.

MagneQuest FS 030 - Still a prototype when I heard it but it holds great promise for the stateside experimenter. Great bass definition and a grainless, colorful midrange -great on sax & trumpet portrayal. Highs were gentle but detailed. My amps vaguely reminded me of a Marantz 8B with more speed and higher resolution behind this hefty piece of iron. Provided a bit more distant perspective on the stage than the other transformers in this survey. More soulful than the TK4519 or XE-60 described below but not quite as "neutral" in character. Might even be better when it hits the street.

Kenyon T-108 - Relatively low grade universal transformer from the 40's. H'mm, better than I expected. Good bass slam, nice full semi-sweet mids but no highs. Your tweeter will sleep right through it. After prolonged listening, I began to detect a slight glare. Okay, it's not great but it's encouraging that there are sleepers out there. Not really worth crawling around in basements looking for it though.

Partridge TK4519 - The classic in the Japanese and Euro markets. Pricey to import and real difficult to find stateside since Partridge didn't want to export to the states because of liability concerns - WARNING: not UL approved. Too bad because this piece lives up to its reputation. Delicate and detailed highs, smooth accurate midrange and fast extended lows. A bit drier sounding than the Peerless FS 030 and *slightly* grainy in comparison, if you want to get real picky. But the tonal balance was right on the mark. Maybe the best full range sound I heard from a single 300B to date.

Tango U808 - Low end of the Tango line. A universal transformer, designed to work in either push pull or single ended applications between a wide range of impedances. Might sound better in a push pull amp or in a lower current single end project but forget it for this demanding application. Wiry, hard, and somewhat fatiguing to listen to for long stretches with the single 300B.

Tango XE-60-3,5S - *Much* better than the U808. Lean and clean, "well damped" sound. Should appeal to those who like what the audio press calls "neutral" and "accurate. Bass is more conrolled and leaner than the low end of FS 030 or TK 4519. Nice gray hammertone case. There are a few even better Tangos which I never got to hear. These might be better yet.

I might change my mind on some of these impressions if I optimized the amp for each transformer by auditioning various caps in combination, blah blah blah. But I was more interested in the overall musical experience while I had each of these transformers on hand. Maybe if I had, say, the FS 030 when I first built my amp, I would have chosen other parts. I assume most constructors will buy a set of transformers and optimize around them rather than running a xfmr test lab. Most listeners will be happy with either the Tango XE-60-3.5S or the Peerless FS 030. Auditioning transformers is like auditioning wire; at some point it pays to give up and just listen to music.

GENERAL CONCLUSIONS

Why single ended instead of push pull, you rightfully ask? As in most things in life, there are good arguments on both sides and it all comes down to 'what you like' in the final analysis. Single ended amps might not provide impressive specs but there are a few points in its favor. So check your handgun at the door and let's look at some of the traditional positions in this long forgotten debate --

Pro push pull
- More power
- Less total harmonic distortion by cancel ling 2nd order distortion
- Never heard of single ended
- Common mode (hum, noise) rejection
- No unbalanced DC in output trans
- Commonly available
- Wide bandwidth
- Deep trust of familiar technology

Anti push pull
- Phase inverters are problematic
- Balanced tubes and other parts necessary to achieve optimum performance. Balance changes over time even if you can get truly balanced tubes to begin with. Component values drift with time and heat..
- Skews natural proportion of even and odd harmonics toward the wicked sound ing odd order kind.

Pro single ended
- Ultra simple signal path
- PURE Class A
- Avoids phase inverter probs.
- Only need $400 worth of 300Bs for stereo
- No need to match parts
- Extra second order distortion sounds good
- Maintains natural harmonic relationships
- Who cares about bandwidth, 99% of the music is there. Some noise missing however.
- Sounds amazing

Anti Single ended
- Low power
- Mediocre specs
- Obsolete, long abandoned technology
- Never heard of single ended
- Can't buy transformer at K-Mart
- Limited bandwidth

Well, I don't think I settled the debate with that discussion. At any rate, single ended triodes sure do sound different in a way that you pick up on a visceral level. The music "feels" different. I would say that typical pentode/beam tube amps have a somewhat "mechanical" or "strained" presentation while the single triode is easy, supple, very natural. As one audio burnout friend remarked, "It's an amp you can fall asleep listening to" - he meant it as a compliment. If you ever got that tightness in your jaw muscles listening to a reference grade "painfully accurate" high end system, you know what we're talking about.

Like many music lovers, I listen to a lot of records that aren't exactly Shaded Dogs. Triodes render scratched, noisy, and plain old poor recordings a lot more palatable than does the contemporary audiophile amp. This is a benefit of the well behaved overload characteristics and tempered third order response of the three element tube. You'll sure appreciate it the next time you decide to listen to some Reggae 45s pressed on stuff that looks like melted-down combs instead of Thelma Houston direct-to-disc.

The organization of musical information is different with a single triode. Detail abounds but is integrated within the music rather than being "etched on" or peaky as with some modern pentode amps. Perhaps this is a result of the presence of third order distortion unbalanced by its even order counterpart in the p-p pentode amp. I haven't heard anything that portrays subtle microdynamics like the single triode. This dynamic agility contributes to the overall wealth of inner detail.

The single 300B really communicates the "groove" of the music, if the music you're listening to has one. In complex ensemble music, the rhythmic integrity and drive of individual instrumental lines is maintained. Still, given its power rating, its an amp for chamber music rather than "The Power of the Orchestra". It simply runs out of steam on all but the most efficient transducers when confronted with Sheffield Drum Record class booming. On most *music*, the dynamic performance of these amps will be a revelation. The exceptional tunefulness of the low end makes up for the limited power and extension on the bottom.

Incredible timbral accuracy is what really makes this amp special. Maybe its the even order distortion that the push pull pentode amp cancels out but it seems that the tonal palette of the single triode is more diverse. You get the woodier wood winds and cymbals and other metallic sounds are more harmonically rich, e.g. cymbals sound like brass not aluminum. Conga drum slaps have a lot more character, music, and veracity. Piano and guitar sound like they are made of steel *and* wood, not *either* steel *or* wood. The textural rendition of this amp is sometimes disarmingly real. Listening to your favorite Miles discs will be a thrill.

Another way in which the single triode differs from a good pentode amp is in the character of the image.There's a "sourcelessness" with good speakers that pentodes don't approach- lots of air without any bleaching out of musicality. It's like you're *in* the soundspace rather than looking *at* it - more *it is here* than *you are there*. Again it's a difference of kind rather than one of degree.

Regardless of the sonic splendor they provide, single ended amps are clearly not for the "spec freak". You simply can't argue for these amps using the standard quantitative measures - you'll lose. The single triode just doesn't rate on paper. I can't imagine what Consumer Reports or Hirsch-Houck labs would say about a Model 91, but it definitely wouldn't be rated as highly as a YORX rack system. Face it, this amp is *rolled off*. Magic between about 50-15K but, in a phrase often reproduced by Mirrophonic gear, "...that's all, folks". *Maybe* that's all the bandwidth you really need anyway.

The power output of this amp is not as limiting as I thought back when I was brainwashed by specs but it does constrain speaker options to some degree. Class A triodes with their low output impedance and high damping factor can really control a cone. A 300B will adequately drive many an efficient (>90dB) box speaker. If you're interested in vintage speakers like old JBLs, Altec 604 or 755, or you have a set of nice horns, you'll never think about the power rating. This amp is a natural for driving the mids/highs in a multi-amp setup. If you refuse to listen to anything but SL600s or Apogees, forget single ended amps.

If you're looking to put together a single triode system, it's wise to recognize that the small amp/efficient speaker and the big amp/inefficient speaker paradigms don't mix well. If you stay within either tradition and exercise good judgement, you can get high quality reproduction. There are always questions of compatibility to be addressed in putting together a system and this is just a special case of that general principle. It's a mighty 8 Watts, but it is just 8 Watts.

This amp makes sense in several contexts: a mini monitor type system with some efficient bookshelf speakers, a multiamp system, or a big super efficient horn type setup. In either case, vintage speakers are more likely to fill your speaker requirements than current high end fare. Stick with high quality speakers made back when

(continued p.27)

SINGLE 300B (Cont. from p. 11)

25 watts was considered a substantial capability and you improve your chances of coming up with a synergistic match. Finding a really good speaker is probably the toughest challenge in audio regardless of which amp you use.

Be forewarned...some may argue that you listen to a single ended amp because it's "exotic". Understand that the knowledge base and deeply held beliefs of people who take progress and the forward march of engineering science seriously are threatened by the astonishing musical performance of single triodes. Can't be that a technology which was thrown out as inefficient and distortion prone before WWII sounds sooo good. You will find that most vocal critics of single ended amps never heard a serious audiophile grade single ended amp. They sure don't like the idea though.

It *is* very interesting that this amp excels according to audiophile performance criteria that were only defined long after its topology was abandoned as obsolete. Shows what an unimportant influence subjective experience had in the development of the technology.

One of the best arguments for this amp is that it cures cases of high end burnout. It's a simple project that you can build yourself regardless of prior experience, a form of deep satisfaction you can't get at your local high end saloon. Since I started rolling my own a couple years back, audio has assumed a much more thought provoking and rewarding role in my life. In other words, it's fun again.

If you're totally non-technical now, try a few projects like this and soon, through osmosis and trial and error, you'll find you understand more than you ever thought you could. If you already know the techie stuff, you may well discover something new in the ancient wisdom of WECO.

Power Cord PLUS

The good stuff for your AC interface

by Gordon Rankin, Wavelength Audio

Over the last several years, many manufacturers of high end equipment have adopted IEC type power connectors. This move toward a standard AC mains connector led to experimentation with aftermarket power cord designs. It is now widely recognized that important shielding advantages and impressive sonic improvements are available through the use of high quality AC wires.

These advantages became apparent to me about two years ago while I was demonstrating a pre-production discrete FET preamplifier at a local dealer. Initially, the result was pleasing. Then we installed the preamp just above an ARC Classic 60 amplifier. This time the preamp sounded terrible - there was considerable noise even without any sources attached. The unit does have high impedance areas which were susceptible to noise pickup. We changed the power cord to a Belden shielded unit. The noise disappeared suddenly and the unit sounded good again.

After this experience, I investigated what was available on the market. I was surprised to find a number of power cords ranging from $100 to over $300 for a six foot length. I bought several of these entries and tested them in the configuration that caused problems with the stock cord I had been using. I couldn't believe the improvement over the Belden shielded cord. The noise radiation problem was eliminated, but there was also substantial sonic improvement in a number of areas. This was starting to get interesting.

I polled several equipment makers and learned that most were using standard grade high gauge wire or off-the-shelf IEC cords for their units. Clearly, one could do better.

In my first attempt at building power cords, I used Romex wire, inspired by a write up in IAR suggesting that since it is what is running in the walls it should suffice. The result was good but not as good as some of the store bought cords. I am against tearing open cables and devices and copying them so I went back to the drawing board. I tried some average grade 12 gauge solid core wire with a copper braid shield and the result was better than expected.

One day, I got some Cardas wire for a prototype amplifier we were building and I tried this as a power cord conductor. In this attempt, I adopted a few aspects of construction and aesthetics from the Cogan-Hall Intermezzo speaker wire kit. The copper braid shield was aplus in the abovementioned effort so I retained it in the prototype of this design.

I braided the three Cardas conductors to cancel any radiation and I used a Wonder Wire™ drain wire for the ground connection. Stretching and taping the braid down every few inches helps the drain wire maintain contact with the braid and keeps the signal wires wrapped tightly. At this point the cable was functional but not very pretty. A nylon braid sheath *a la* Cogan Hall over the copper braid gave the unit a finished and "professional" appearance.

Compared with the other cables I had been auditioning, this cable provided a more spatial sound with enhanced definition. On track 5 of Ricki Lee Jones *Flying Cowboys*, the oscillation of the vibrato contoller was cleanly articulated. The other cables were somewhat smeared in the vibe passages in comparison. Overall, there were surprising differences for such a simple change.

On extended listening, I liked this cord so much that I now include it with my Wavelength Audio products. The cord is not available separately but here are plans for you to build your own or provide inspiration for your experiments.

DESCRIPTION

The *Power Cord Plus* uses Cardas 14.5 ga. wire for hot and neutral leads and 18ga Wonder Wire™ as a drain, a tinned copper braid shield, and a nylon braid covering. The wall end is terminated with a hospital grade mains plug and the female end is terminated in a high grade IEC connector. This configuration will work with all equipment using male IEC connectors.

PARTS FOR AN X FOOT CORD

1- Three lengths of 14.5ga Cardas Golden Stranded Chassis wire at (X+0.75") each
2- X feet of tubular copper braid 0.375" dia.
3- X feet of nylon braid 0.5" dia.
4- X feet of Wonder Wire™ or other tinned solid 18ga. conductor
5- Hospital Grade three prong power plug
6- IEC female connector (15A-25A) with as large an opening as possible
7- Electrical tape precut in 1.5" lengths (approx. 10-15 pieces)
8- Heat shrink tubing: One 1.5" piece of 0.75" dia., two pieces of 0.25" dia.

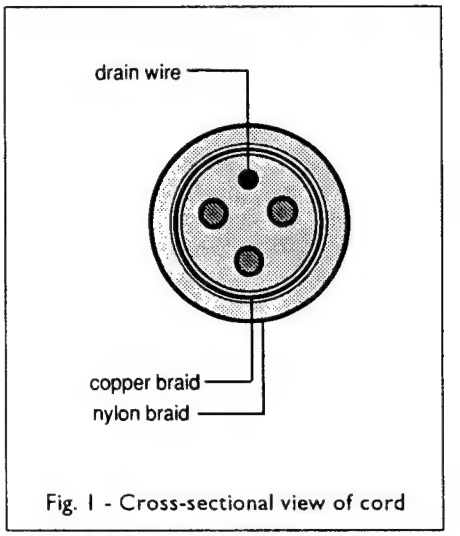


Fig. 1 - Cross-sectional view of cord

EQUIPMENT REQUIRED

1- Solder pot or high wattage iron
2- Needle nose pliers, cutters, and scissors
3- Ruler or tape measure
4- Heat source for the heat shrink tubing

CONSTRUCTION

Dimensions are given in terms of offsets so that the user can create any length of cord.

Prepare the three 14 ga. conductors in the following manner: Cut lengths about 3/4" longer than the proposed length of the cable. Strip about 0.25" from each end of the wires. Using a solder pot or a high wattage soldering gun, tin both ends of all three conductors. Mark two of the three wires with a marker or heat shrink, unless you have two or more colors of Cardas wire. I use red and yellow heat shrink to mark hot and neutral conductors.

Line up the ends of the three wires and tape them together about 1" from one end in a tight bundle. This will be the wall end. Braid the three conductors up to the other end and tape them together about 1.25" from the end. This will be the equipment (IEC) end.

Line up the 18 ga. drain wire with the unmarked (ground) 14 ga. wire. Tape it in place about 1" from the wall end, then spiral it around the braided wires. Tape it in place about 1" from the other end and clip off any excess.

Temporarily tape over the ends of all conductors at the wall end. This will facilitate threading these wires through the copper braid.

Trim the copper braid to 1" less than the proposed length of the cable. Start at the end you just taped over and feed the cable through the braid. Tape the braid tightly around the wires about 1" in from the equipment end then, while pulling the braid tight, tape every six inches or so. This will ensure good contact between the braid and the drain wire. Trim any excess braid off at the wall end and tape it down about 1" from the end. *Make absolutely sure that the braid can not come into contact with any power leads.* The copper braid will get your hands really dirty, so go wash them after this section of the operation.

Trim the nylon braid to 1" less than the proposed cable length. Starting at the wall end, inch the nylon over the copper braid. Make sure that the copper braid does not bunch up while doing so. Pull the end of the nylon just over the end of the copper braid and tape it off *very* tightly. Be sure that the tape does not show beyond the rubber sleeve of the female IEC connector. Smooth out the nylon braid over the length of the cable, tape it down 1" from the wall end and trim any excess.

Remove the temporary tape from the wall ends of the wires. Place the heat shrink tubing over then end of the wires and adjust so that about 3/4" of the conductors is showing. Shrink the tubing until the nylon pattern begins to show through the tubing.

At this point, take apart the female IEC connector. Take the rubber sleeve out and position it on the equipment end of the cable. There should be about 1/2" of conductor showing. Insert the conductors into the channels of the IEC connector and bolt them down. I find it useful to square the ends of the connectors using a pair of pliers for better fit and greater surface area for the screw down contact. Close the IEC connector and bolt it together. The connector should close completely, though I have had battles with my needle nose pliers getting everything squeezed in when using large gauge wire.

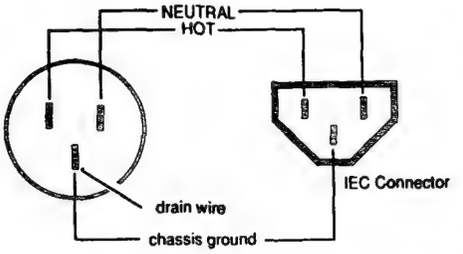


Fig. 2 - Connector diagrams

Take apart the wall plug and place the strain relief portion over the cable. Make connections per Figure 2. Make sure that the drain and chassis ground conductor are fed into the center position. Use an ohmmeter to make certain that all connections are correct and that no shorts between conductors exist. It is easier to change connections on the wall end of the power cord if necessary. This completes construction of the cable. Plug it in. Enjoy.

The Power Cord Plus can be used with any source, preamplifier, or amp up to 100W. For amps bigger than 100W, heavier wire is indicated because of increased current. Be prepared to get frustrated over the limited working area of the female IEC connector when using wire heavier than 14 gauge.

FOR FURTHER EXPERIMENTATION

Here are a few suggestions worth trying which I have not yet implemented:

1- Put IRON cores around the signal leads to filter out HF noise components. Fix placement with heat shrink.

2- Put a low value resistor in series with the chassis ground connection to filter out digital noise in CD and DSP units. Some digital AC cords omit the chassis ground connection entirely.

3 - Run multiple thinner conductors in parallel for each conductor. Tightly twist or braid these together.

4- Michael Percy reports excellent results using a pair of .1 caps from chassis ground to neutral and hot leads. Be sure to use AC rated caps or units rated *at least* 600 VDC for a 120 V line.

PARTS SOURCES

Parts for Power Cord Plus are available from Michael Percy, Triode Electronics, and many other audiophile suppliers. If you have any problems sourcing parts feel free to contact me at Wavelength Audio.

Gordon Rankin
Wavelength Audio
4539 Plainville Road
Cincinnati, OH 45227
513-271-4186 phone/fax/voice mail

Michael Percy
Box 526
Inverness, CA 94937
415-669-7181
415-669-7558 fax

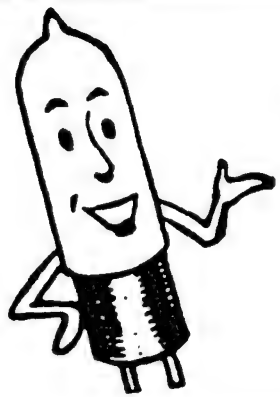
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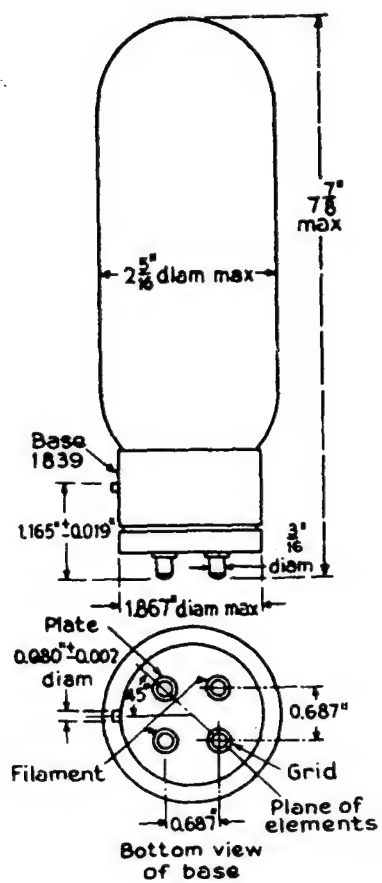
Radical and Tube-ular

ADAPT tube hybrid, and ATAS pure tube analog, digital audio processors

Anodyne Group . Post Office Box 6227 . High Point, North Carolina 27262-6227
office 919.884.7394 facsimile 919.884.1072



Meet the Tube ... the mighty 845



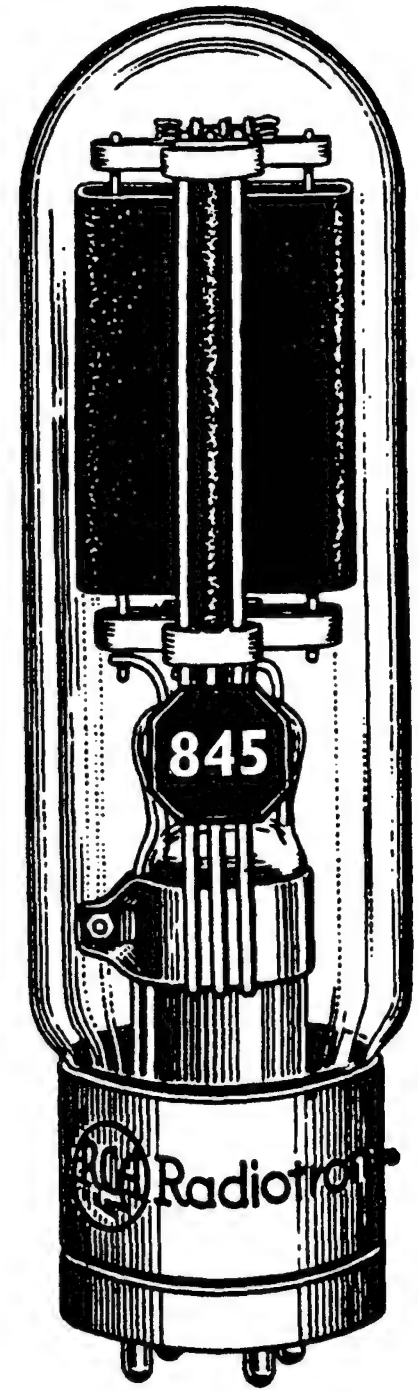
Wow! No tube inspires more fascination, respect, and desire than the large glass triode.

You can just imagine them cooking away in the transmitter room of an all night blues AM station in Chicago back in 1952. Or 1942, or 1972 . . . like all classics, it's beyond time and place. It's been there.

Seldom seen in the home, the 845 is an undomesticated animal, requiring death-defying voltages to make it sing.

Its tungsten filaments give off a bright, white hot glow.

It is a commanding presence; the big triode doesn't bow to miniaturization. It is never an afterthought.



TRANSMITTING TRIODE 845

CLASS A MODULATOR

100 WATTS INPUT

List Price **$10.00**

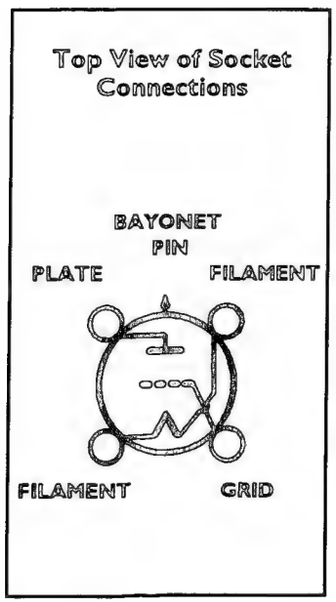
RCA-845 is a low-mu transmitting triode of the thoriated-tungsten filament type designed specifically for use as a class A audio-frequency amplifier and modulator. It may also be used in class AB_1 audio service. Two 845's in this application are capable of delivering approximately 115 watts of power with very low distortion.

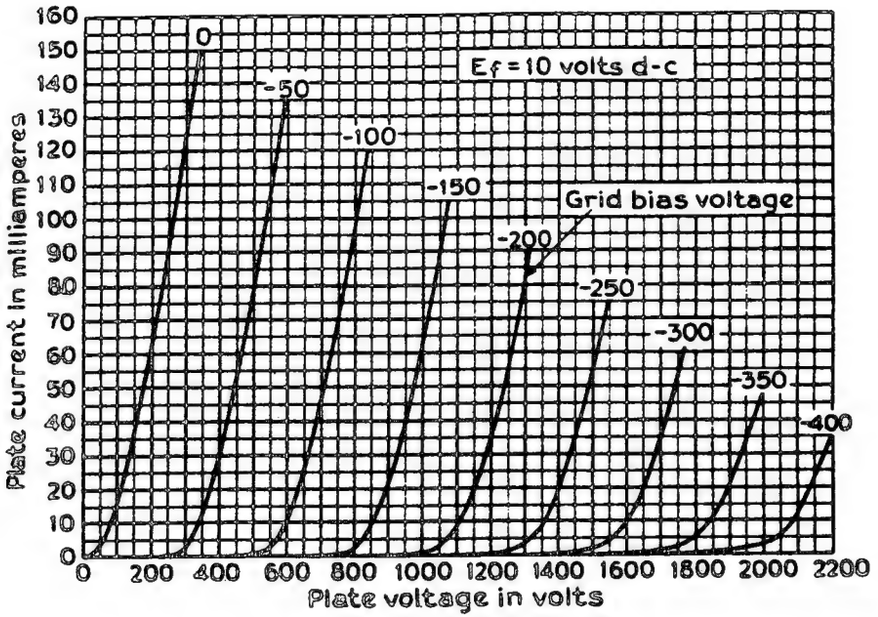
Typical operating conditions for a single 845 in class A service are: D-c plate voltage, 1250 volts; grid bias, -195 volts; d-c plate current, 80 ma; and undistorted power output, 30 watts. Typical operating conditions for two 845's in class AB_1 service are: D-c plate voltage, 1250 volts; grid bias, -225 volts; zero-signal d-c plate current, 40 ma; maximum-signal d-c plate current, 240 ma; effective load resistance (plate-to-plate), 6600 ohms; and maximum-signal power output, 115 watts.

The 845 is one of RCA's three famous "50-watters". It has maintained its reputation for long, reliable service through the years of radio communication. For real audio power with low distortion, RCA-845 is the answer.

RCA Guide for Transmitting Tubes, 1941.

The 845 was already a classic by 1941 -- designed for AUDIO, pure and simple.





845

MODULATOR, A-F POWER AMPLIFIER

Filament	Thoriated Tungsten			
Voltage	10			a-c or d-c volts
Current	3.25			amp.
Amplification Factor	5.3			
Direct Interelectrode Capacitances:				
Grid to Plate	13.5			μμf
Grid to Filament	6			μμf
Plate to Filament	6.5			μμf
Maximum Overall Length				7-7/8"
Maximum Diameter				2-5/16"
Bulb				T-18
Base				Jumbo 4-Large Pin
RCA Socket				Type UT-541 ←

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

A-F POWER AMPLIFIER & MODULATOR - Class A_1

D-C Plate Voltage			1250 max.	volts
Plate Dissipation			100 max.	watts ⇐
Typical Operation:				⇐
D-C Plate Voltage	750	1000	1250	volts
D-C Grid Voltage°	-98	-145	-195	volts
Peak A-F Grid Voltage	93	140	190	volts
D-C Plate Current	95	90	80	ma.
Transconductance	3100	3100	3100	μmhos
Plate Resistance	1700	1700	1700	ohms
Load Resistance	3400	6000	11000	ohms
U.P.O. (5% second harmonic)	15	24	30	watts

NOTE: In cases where the input circuit to the 845 is resistance coupled, the resistance in the grid circuit should not exceed 0.5 megohm when cathode bias is used. Without cathode bias, the d-c resistance in the grid-coupling circuit should not exceed 0.1 megohm.

A-F POWER AMPLIFIER & MODULATOR - Class AB_1 ⇐

D-C Plate Voltage		1250 max.	volts
D-C Grid Voltage		-400 max.	volts
D-C Plate Current		120 max.	ma.
Plate Input		150 max.	watts
Plate Dissipation		100 max.	watts
Typical Operation:			
Unless otherwise specified, values are for 2 tubes			
D-C Plate Voltage	1000	1250	volts
D-C Grid Voltage°	-175	-225	volts
Peak A-F Grid-to-Grid Voltage	340	440	volts
Zero-Signal D-C Plate Current	40	40	ma.
Max.-Signal D-C Plate Current	230	240	ma.
Load Resistance (per tube)	1150	1650	ohms
Effective Load Res. (plate to plate)	4600	6600	ohms
Max.-Signal Power Output	75	115	approx. watts

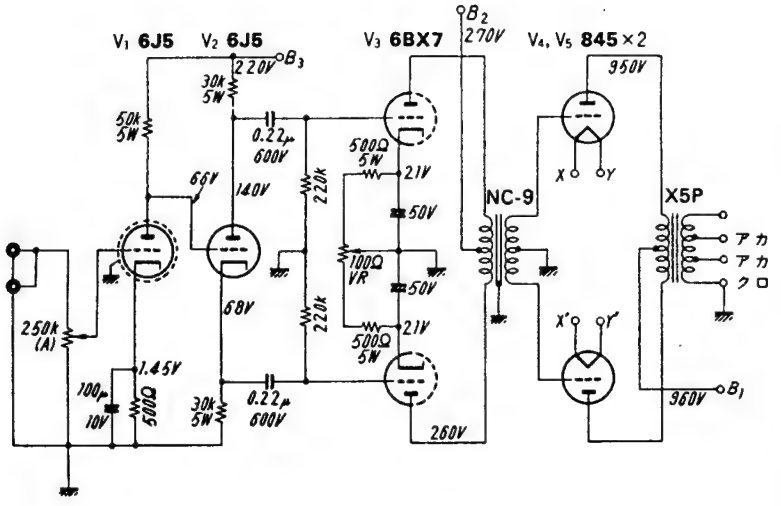
° With a-c filament supply.

OUTLINE DIMENSIONS, TUBE SYMBOL, and SOCKET CONNECTIONS for the 845 are the same as for the 211.

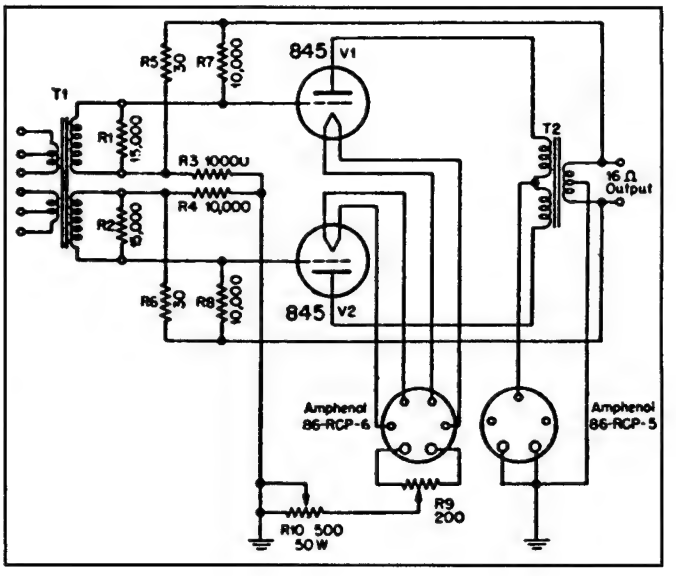
⇐ Indicates a change.

April 15, 1940 — RCA RADIOTRON DIVISION, RCA MANUFACTURING COMPANY, INC. — DATA

As these plate curves indicate, the 845 is a tube of impressive linearity.

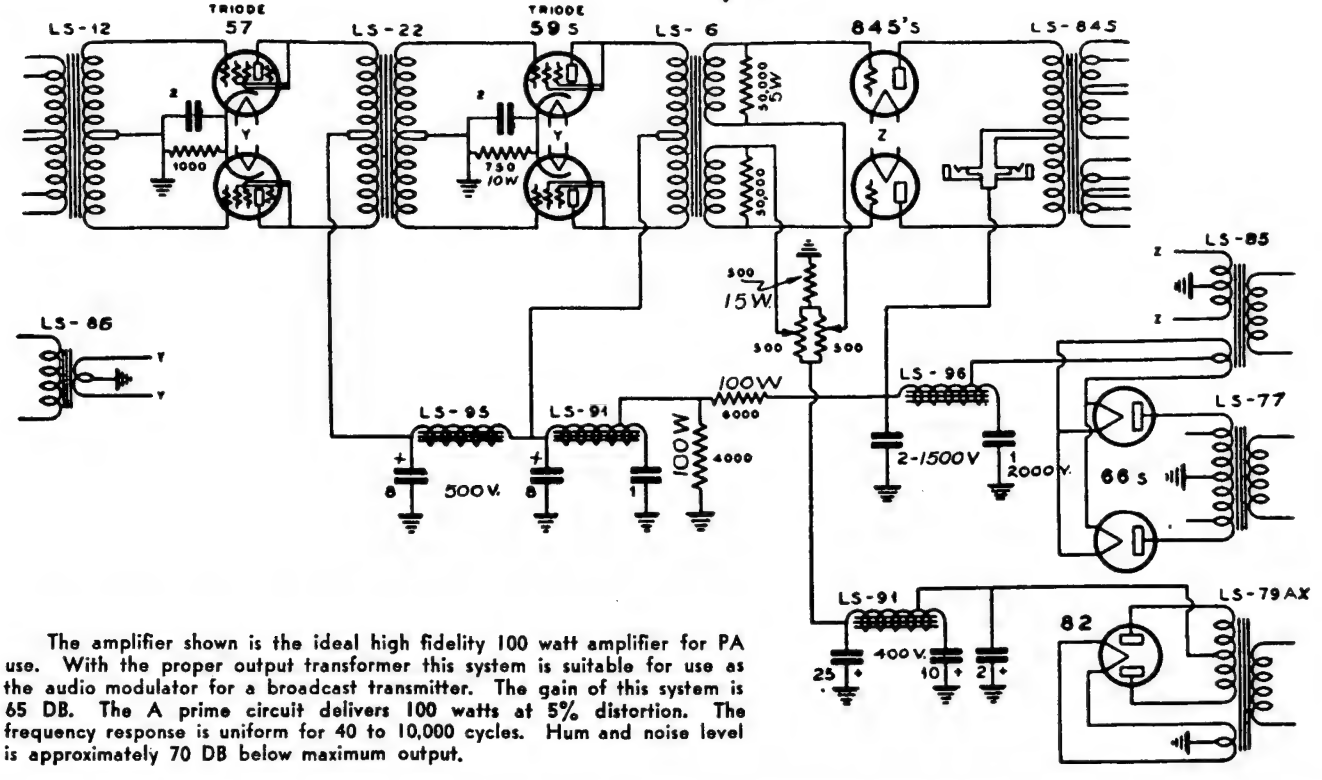


In this circuit from *MJ*, a Japanese audio experimenter's magazine, the driver stage is transformer coupled to the 845 grids. Because of the high drive requirements of the 845, interstage step-up transformers are often used to provide undistorted signal voltage of adequate levels to the output stage. The amp provides 80 watts output Class AB_1.



This is the audio section of the Musicians' Amplifier Senior from *Audio* January 1951 (reprinted in *The 2nd Audio Anthology* available from Old Colony). It is a "booster amp" which is itself driven by a power amp. Good for 40 clean watts Class A. This amp is a descendant of the Western Electric 87 and the Altec 287F - a design which dates back to the 1930's.

from the 1936 United Transformer Company catalog



The amplifier shown is the ideal high fidelity 100 watt amplifier for PA use. With the proper output transformer this system is suitable for use as the audio modulator for a broadcast transmitter. The gain of this system is 65 DB. The A prime circuit delivers 100 watts at 5% distortion. The frequency response is uniform for 40 to 10,000 cycles. Hum and noise level is approximately 70 DB below maximum output.

The Core Issues:

Choosing a Power Transformer

by Michael S. LaFevre, MagneQuest Transformer Co.

"The Core Issues" will examine the function, construction, design, and operation of magnetics for audio applications. This series will combine practical advice in the form of useful "rules of thumb" with enough pure theory to give us some concept of how these magnificent devices work. This column is not an academic engineering tutorial but rather a guide to becoming an informed consumer.

This series begins with a look at the theory and operation of the power transformer. Power transformers are relatively uncomplex devices compared with output transformers and are often given only the most cursory attention by audiophiles. More often than not, they are treated generically. "Oh, all you need is a transformer that will supply, say, 360-0-360 VRMS @ 200 mils for the plates, a 6.3 VCT @ 4A filament winding, and 5 volts at 3A for the rectifier tube." Beyond this point, the consumer is often at a loss as to how to properly select a good unit or is misguided by myths about magnetics. Where do we go from here?

In the ideal world, power transformers are conceptually pretty simple. We want the transformer to either step up (increase) or step down (decrease) the voltage supplied to the primary. Power transformers, like all transformers, are simply ratio devices. If you have 100 turns on the primary connected to a 120 VAC supply and you want 360 volts on the secondary, then there must be 300 turns of wire on the secondary--i.e. a 1 to 3 ratio. To obtain our 5V winding, the primary voltage of 120V must be stepped down by putting fewer turns on the secondary. The exact number needed is 4.1666 turns. In the ideal model, turns ratio precisely equals voltage ratio.

The ideal model assumes a perfect conductor with zero resistance. Therefore, the size of the conductor is wholly unimportant and can be infinitely small for convenience. But, and this is a big but, we do not live in an ideal world. In the real world, we must contend with a variety of electrical and magnetic phenomena that blow our ideal models to hell and back. There are always losses when using real materials, e.g. copper is one of the better conductors, but it significantly inhibits the flow of electrons. Similarly, losses occur due to the properties of core materials.

Due to the resistance of copper, not all of the 120 volts applied to the primary will be available to be stepped up or stepped down. Some of the voltage will be burned up (gone forever) in travelling from one end of the copper to the other. The telltale sign of this inefficiency is heat. The lost voltage is reincarnated as a temperature rise. The steel laminations also introduce losses that are not accounted for by the ideal model. Our ideal model assumes infinite permeability and proposes that the laminations will not, in fact cannot, be saturated ("overloaded"). Real transformers aren't like this, unfortunately.

The value of this ideal model is to demonstrate the underlying simplicity of the device and to reinform us as to where deviations from the ideal occur. But you can't buy an ideal transformer.

If it's not possible to have an absolutely perfect transformer, "one that simply transforms", then what should we realistically seek? First and foremost, we want to obtain our specified secondary voltages -- using our earlier example, we need 360-0-360 while the transformer is delivering its fully rated 200 mA current. Also, we would like to minimize the variation in this voltage even when the circuit is pulling considerably less than the full current for which it is designed. In other words, we want the voltage to remain relatively constant from no-load to its maximum current capability. This is called "voltage regulation". Many power transformers (notably stock Dyna iron) exhibit pronounced voltage sags at maximum rated current. A well-designed and properly built power transformer can achieve a remarkably high degree of voltage regulation. Next, we would like it to run relatively cool. And, we would like it to be as physically small as possible without sacrificing performance. And we would like it to be as inexpensive as possible without trading off real performance for dollars.

Let's take a look at a few dubious claims about power transformers you're likely to encounter in the audiophile press. In philosopher's parlance, these are "fallacious arguments". By examining these fallacies, we can develop a better perspective on important performance parameters that must be considered in choosing transformers.

One of my favorites was an ad that advised hobbyists to buy the house brand of power transformers because they were heavy -- the assertion being the more weight, the better. Another good one was the high end manufacturer who claimed that to get your money's worth you should buy a transformer that runs hot. A widely held and popular belief is that you should buy a mil-spec trans. The supporting logic is that because Uncle Sam has an unlimited budget and only buys the best components, the smart consumer benefits by buying them on the surplus market for pocket change and makes a real killing because its "mil-spec" and, therefore, a high-performance unit. But by far the most common misconception is that a power transformer with double or *triple* the current capacity actually required will yield a better performing transformer than one that is rated at the maximum current honestly necessary for proper operation of the circuit at hand. This is a potentially dangerous assumption.

Let's start with the weighty issue first. The assumption is that you will get more for your money. But more of what? Often, but not always, a transformer is beefy because it utilizes a low grade of electrical steel. Transformer laminations come in a multitude of grades ranging from M6 to M55. The lower the number, the lower the core losses as measured in watts loss per pound of material. This is because the reluctance (the magnetic equivalent of resistance) of

M6 is lower than the lesser grades with a higher number behind the "M". The higher the number, the higher the losses; therefore, you must use more (all other things being equal) of M19 for a given VA (power) rating than if you use M6. As the number increases, the saturation point falls lower and lower. Even if you run M19 at lower levels of flux density, magnetic distortion is still greater than for the more premium grades of laminations at the same operating level. Simply put, you must use more M19 to build our example transformer than you would need using M6 and your iron losses will be greater if all the other design considerations are equal.

This is not meant to say that you should always reject a power transformer if it is heavy. Some power transformers built with M6 are heavy, and some transformers built with M19, M22, or M27 are designed to provide reasonable performance levels. The big mistake is to make decisions based solely on weight without knowing anything about the composite performance capabilities. We must know what the voltage regulation of the unit is, what temperature rise to expect, how current capacity was calculated, what flux density level the unit runs at, etc. Just don't buy on weight alone since it might indicate cost constraints imposed by the manufacturer (M19 and M27 cost 40% to 70% less than M6) and a heavy unit may have poor overall performance characteristics.

Another misconception is that a transformer should run hot if you're getting your money's worth. Actually there is a small grain of truth in this assertion, but only if you don't particularly value characteristics like good voltage regulation, low magnetic distortion, and the like. The aviation industry, for instance, will tolerate extremely high temperature ratings in order to gain small size and weight. But for audio projects, especially quality projects like building 300B amps, this would be a very unwise tradeoff. To get a transformer to run hot, we can do any number of things: use a poorer grade of lamination, keep the size of the lamination small, use small diameter wire in the windings, or operate a good grade of lamination at very high flux density levels. Presto, it'll run hot. Sort of like a New York City Saturday Night Special. Will it survive? If it is built with class B insulating materials that are rated for 105° C operation and it truly runs hot (say it has a 75°C or higher temperature rise when pulling a full load) on the surface, then we are probably flirting with disaster. But even under these conditions, more than likely, it will survive. Forced air cooling would provide an added measure of safety.

Remember that inside the transformer there will be localized hot spots that operate at 15 to 20° C hotter than the surface. The aviation industry gets away with running iron hot because they specify insulation materials rated for 155°, 180°, or 220° C environments and they're willing to sacrifice some performance factors for small size/weight. Most consumer and industrial power transformers use 105° or 130° C materials which are adequate for a transformer without serious design flaws. If your manufacturer specifies temperature rise, look for a unit with a 35° to 55° C rise. Transformers with a 55° to 75° C rise are less desirable but worthy of consideration if all other performance factors are acceptable. Pass it by if rated at 75° C or higher rise. Again, don't make decisions based on any single performance criterion -- look at the composite characteristics.

Let's examine the most common misconception: that radical derating of transformers leads to better performance. In our ideal transformer model, the voltage ratio is equal to the turns ratio. If you built an actual transformer according to the model, the actual voltage increase will be smaller than anticipated. Why? Because there are always resistance losses in the copper and iron losses in the laminations. How much less depends on the grade and size of lamination, the size and length of the wire, the varnish or impregnant used, the type and amount of insulation employed, type of housing, and yet other factors. The principal determinants are the copper and iron losses mentioned above.

In practice, we can compensate for voltage losses by adjusting the turns ratio. To achieve a given voltage ratio, we need a slightly higher turns ratio. The adjusted turns ratio is calculated by taking into account a number of factors which are related to current flow: copper and iron losses and temperature rise (resistance and core losses go up with temperature). We need to calculate losses at full load so our transformer will deliver the target voltages with good regulation. The current values plugged in to the formulae must be the ACTUAL maximum conditions which the circuit will demand of the transformer. Otherwise, the secondary voltage will be a surprise.

Suppose a customer specifies a 400 mil transformer instead of a 200 mil transformer. OK, this requires a significantly different design. It will be larger and it will need heavier conductors in the primary and plate windings to offset increased I^2R losses. The voltage regulation of this transformer will be about the same with 400 mA as the smaller transformer would have with a 200 mA load. The customer is right in one respect-- if he only draws 200 mA from a 400 mA transformer, there shouldn't be any problem with voltage sags as with the Dyna iron. But is he home free?

By overstating current requirements, our friend will end up with a transformer that delivers a voltage higher than optimum for a given circuit. The compensated turns ratio for 400 mA is higher than for 200 mA. Therefore, he *might* get better voltage regulation and a cool running transformer, but at a voltage which is assuredly higher than bargained for. Not only the plate voltages but all secondary voltages will be too high since copper losses in the primary will be less than anticipated. The ultimate costs of this error could include decreased reliability and longevity of tubes, caps, and other parts or even improper operation of the circuit. The wise move is to get a competently designed unit at the desired voltage and realistic current levels.

A few more notes on current capacity: The current rating of transformers is what I would call a "soft" number. If a manufacturer says his unit is rated at 300 mA but provides no further info, we have not learned enough to evaluate the import of his claim. Perhaps it will deliver 300 mA, but only at a 90° C rise or it might drop so much voltage at 300 mA that the initial design target voltage is inaccessible. Voltage regulation might be poor indeed at 300 mA. To really judge this claim you would need to know at least the temperature rise and voltage regulation from no-load to full load. Current capacity specifications can vary between very conservative and wildly optimistic. Be sure you're comparing apples with apples. If two units give the same voltage and current specs, try to find out more about how it was designed with respect to voltage regulation, temperature rise, flux density level, etc. Don't treat the two units as "generic" equivalents

performance-wise without first getting as much information as possible.

Here are a few characteristics to look for when choosing a power transformer.

- A 40° to 55° C temperature rise
- M6 material
- A copper current density level of 600 to 1,000 circular mils per amp (the higher the better)
- Between 3% and 6% voltage regulation
- Insulated hardware
- A flux density level under 15 kilogauss
- Mechanically quiet
- Electrostatic shielding between primary and secondary windings
- Designed for the current that your application requires

Don't use this as a rigid checklist since there are many good designs out there that will fail to meet one or more of these criteria. In general, these are indicators of a quality transformer.

Lastly, a few comments on mil-spec transformers. Many audiophiles are under the misconception that mil-spec transformers are somehow superior to other, commercially available units. In reality, Mil T-27 addresses issues relating to physical packaging of transformers almost exclusively. Specific requirements are laid out to ensure a high degree of mechanical integrity for phenomena such as vibration and shock, salt spray, flammability, fungus proofing, altitude testing, etc. On electrical matters such as voltage regulation, current capacity, temperature rise, core material and grade, or permissible flux density, Mil T-27 is wholly silent. In fact, unless the government agency or the approved contracting agent specifically lists particular performance parameters, the units supplied must only meet longevity (as measured by insulation life), corona standards, and minimum standards for insulation resistance.

Unless you're privy to the actual contracting order, you cannot be sure of the actual performance parameters (if any were specified) to which the transformer was designed. You could wind up buying a unit that offers no real advantages over other designs. But, of course, those surplus items are available cheaply and have great appeal to constructors on a tight budget. But it really is taking a shot in the dark from a performance point of view.

When shopping for transformers for your next project or design, it may be useful to review some of the points in this article - especially the "indicators of quality" outlined above. In certain cases even more information will be necessary. For instance, this article does not address very important issues like rectification and filtering on AC voltages and currents, a topic of great import in choosing your power components...More on this important topic later.

In the meantime...Happy building!

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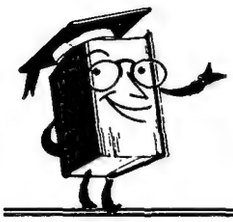
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from the archives

Excerpted from

Prerequisites for Capturing the Musical Experience

by Robert Fulton

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Robert Fulton has been a recording engineer for more than 30 years. For the last 15 years, he has been designing professional and home playback equipment

One of the questions that's asked of us most often at seminars is, "What's best, solid state or vacuum tubes?" Isn't that a nasty one? I sometimes answer by asking, "What year are you talking about?" Let's go back to the time of Edison. Thomas Alva Edison, the inventor of the phonograph, the ticker-tape, the light bulb, and hundreds of other items, had patent after patent after patent. Edison, in his magnificent genius gave us the vibrations on foil. They were called "hill and dale" recordings, up and down, just as the natural diaphragm would move up and down. People I used to know told me of incredible recordings and playbacks made of Sousa's band. What an incredible thing Edison must have put together with a moving diaphragm and a special chamber. No vacuum tubes, no microphones, no wires, no amplifiers, no speakers, no transistors, no resistors, no capacitors, no rectifiers, nothing. All mechanical, not unlike the ear.

Then we got more sophisticated and we added the thing which, in a way, Edison helped to invent. You recall, as he was working on the light bulb, he put another element in the vacuum and showed that current could be passed in one direction, from the heated cathode or filament to an other element, an anode or plate. Edison just stored that away and basically gave us the diode, or rectifier.

It was for De Forest to come by and put a third element in the tube, called the grid, or the stop-and-go light for the electrons inside. This grid was a little wire mesh which would increase the flow of electrons, or decrease them, depending on the type of bias or voltage that was impressed on the now third element. This was the classic triode tube - simple, honest, reasonably linear. And it could be counted on to give a reasonable replica of the input voltage at its output. It kept things in time, was quiet, spoke with dignity and majesty. And so in the '30s, all the amplifiers had triode tubes in them, numbers like the 01A, the 56, the 27. There was the 45, the pristine Class-A amplifier of all time. Then there was the more powerful 2A3, and then the 6A3 and the 6B4. The transmitter people had the absolutely magnificent 845 power tube.

Now after that, the British and others put additional elements in the tube for greater power output and gain (numbers). When the tetrode and pentode, with other elements in them, arrived on the scene, this increased the complexity but also the distortion, and ruined the linearity. Everyone started making amplifiers that had high power sensitivity at the expense of quality. The minute we did that we were reduced to a hog-calling contest. And in order to make it palatable for even the average American, we had to put in a thing called feedback, negative feedback, where we feed a portion of the output signal back into the input to try to con Humpty Dumpty back together again.

Oh yes, the numbers became better, and this got better, and that got better, and we talked ourselves into it. Later we learned that feedback was a bad thing. The concept is bad. It's not always executed badly for industrial power applications, but the concept is bad musically. When you feed enough signal back, you now have destroyed the musical experience. That first note is already on its way to the speaker, and you're feeding it back again and recirculating it back through the amplifier again and again. Not for my ears, thank you.

Now, solid-state comes by and takes the same bad ideas, with the same kind of remote cut-off characteristics, even sharp cut-off, so they become literally switches, on and off. We dump all that in there and say, "aha", just like the vacuum tube. We've already prostituted the vacuum tube for audio by putting more than three elements in it. Not too swift.

As usual, poor audio is at the low end of the stick, and we have to take the hand-me-downs. After the 2A3, the 45, and the 845 power tubes, everything's a hand-me-down. A company makes the 6550 available for industrial use, the British come out with the KT77. Where does that leave us? Right back in the soup. Williamson comes by and says well, we'll make triodes out of them, we'll put another tap on the output transformer and run the screen there. In some ways it got very bad, even horrendous. There was no way to put Humpty together after that one.

In a way I can see how not-ready-yet digital is sneaking in. We have no regard for the beauty and majesty of music when we cut it up and slice it up and feed it back and chop it off. It's one thing to make an operational amplifier for industry, for turning things on and off, but let's not mess up audio. Let's not apply the same lazy technology to audio. Audio for music is more demanding. Real audio isn't just one signal, real audio isn't just a sine wave. Real-time audio is thousands, I mean we're talking hundreds of thousands of bits and pieces of events coming by in an instant of time. And we're going to mess it up by playing games with the signal, and not letting it come through in a natural, unabated way? It's already having enough problems just getting electrified from the acoustic instruments.

To really answer the question at the seminar would be to say something like this: you want to tell them that neither one is any good, that they're a travesty, both of them. However, we can't tell them we've literally emasculated everything when we ran it through those wretched devices. So what we can say is that it's very possible, in this modern day of enlightenment with the topology available to us, to do something. But when was the last audio tube made? I challenge you, when was the last audio tube made in the United States? When was the last audio transistor made? These are topics for a separate discussion. We could say that, given "A" and given "B", it would be technically possible at this

time to build an amplifier with vacuum tubes, and an amplifier with transistors, which could be equal, musically speaking. I'm not saying it's being done in either discipline. We've done it in our laboratory on a one-to-one basis. When was the last time you found a good 12AX7? Gets kind of quiet, doesn't it? When was the last time you were able to purchase a super high-quality output transformer, or for that matter a decent power transformer? It seems like the transformer people have all gone away. The vacuum tube people have all gone away, there's no new design going on, just the same old humdrum. The same is true in the solid-state field as applied to real audio.

Engineering students ask, "I wonder if we should regulate the whole power supply on this one?" It should have been completely regulated from the beginning. We try to get by for nothing and it's not working. And so, accidentally a few receivers come from outside the country and perform musically above some of our better equipment - kind of a tragedy. Of course, most imports cannot separate anything out, nor can one identify the correct timbre of many of the more complex instruments. Audio is an American heritage. Are we going to keep it that way?

I really believe that someone somewhere ought to be working on a really good output device for amplifiers. The output stage has got to perform. It's got to have control. It has to have musical sensitivity, and be graduated. It must have enormous reserve. We can't get it with gimmicks. We need to produce a design with teeth in it and with real power in it. We've got to imitate the triodes of old. They're past us now. It's gone away. There's an occasional rumble of new development here and there but nothing's happening because something is always overlooked. We're not applying ourselves, we're just dabbling at it. I think it's a sad commentary on out time in history that we don't have a device that really cuts the mustard.

Some have had the audacity to suggest that now that the amplifiers have been perfected, we have to do something with the speakers. Hogwash. Pure, unadulterated hogwash. In some ways, some speakers are better than any amplifier that's ever been produced. The amplifier has a long way to go, a long, long way. We barely had vacuum tube technology down to where we could even get a handle on it, and all of a sudden we're ushered into solid-state. We still haven't overcome that disastrous dilemma.

We're a long way from putting an amplifier together that's musically satisfying. Yes, we can put together amplifiers for shaker tables, for industrial use, and for calling the hogs. Might even work at the State Fair, but to take home and put in a music system? I'm afraid we're still working on that.

DISCUSSION

Over the years, Fanfare has given us some thought-provoking commentary on the audio scene. As a music lovers' publication, it is on somewhat neutral ground as regards the audio business and it provides a forum in which the technically proficient can speak to fellow music lovers. In this excerpt, the late visionary Bob Fulton presented a fundamental critique of the devices which are brought to bear on the challenges of musical reproduction.

He takes in the big picture, portraying almost the entire history of electronically reproduced audio as a downward spiral. In compliance with the "no free lunch principle", the most linear devices, e.g. triode tubes, compromise other specs - power, total distortion, economy... - and they were abandoned for such extra-musical concerns. In Fulton's position the choice is clear and the industry chose wrongly.

A paradoxical subtext of his article is that the complexity of music demands technological simplicity. Music is an incredibly complex and subtle phenomenon but the most appropriate technology for reproduction is one which is elegant, honest, and simple - or at least one free of unnecessary complexity. It is interesting that the earliest and most obvious ways of reproduction are the most well tuned.

"We can't get it with gimmicks", as Bob puts it. Indeed, clever "engineering", he would argue, is typically at odds with the goals of "audio musicianship". "Something is always overlooked".

Perhaps some day we will see the better device Mr. Fulton wished for. Until the day science catches up, artists like Bob Fulton will constitute the vanguard.

IT WILL STAND

Herbert Reichert, Staten Island, NY

"You take some music, sweet flowing music, some movin' and groovin'... heart beats drums beat... hear those sax blowing - sharp as lightning - hear those drums beat loud as thunder... see why it will stand... some people don't understand it that's why they don't demand it... you might as well claim it... sinking deep into the heart of man. It will be here forever and ever... I feel good, let's do it again... It will stand."

Norman "General" Johnson

1957 - I am eight years old and my mother has just set me loose in Marshall Fields to pick out my birthday present. I go straight to the mahogany and glass listening booths and put the tonearm down on Elvis' "Loving You". That was my first record purchase. As I type this I am listening to that same record.

1966 - Down in the basement, walls covered with Hendrix posters, I turn the volume up on Sonny Boy Williamson and the Yardbirds. This time the music is not coming from the 15 inch speaker in my parents' Columbia hi-fi but from my own Garrard turntable, Olsen preamp and two Fender Reverb amps. Strange system but it played Rock and Blues to suit my teenage chemistry.

1992 - Thirty-five years of Elvis, Bach, Louis Armstrong, George Jones, Irma Thomas, Patsy Cline, et. al., has taught me one sure thing: there are an infinite number of musical thrills, goosebumps, tears and laughter available in front of your home music reproduction system.

Reproduction of music in the home asks the listener to fill in perhaps 90% of the total information. No other private emotional experience requires this involvement. Yet billions of records and millions of reproduction systems testify to man's desire for this type of experience. How much and what type of information does one need to become involved in a recorded musical experience? CD has made this the most important question in audio. I am convinced that more information is better BUT the *quality* of information is far more significant. What is crucial is that the system makes us want to listen and not limit the types of music we want to explore.

What does this have to do with WE-300B's? Let me explain. I never really wanted a "Hi-Fi" system, just something rugged and honest that puts me in sync with the music. I wanted to feel the Stratocaster and Deluxe Reverb. I wanted to respond to the weight and tone of a Steinway and Bosendorfer. I liked to hear the tubey sound of a Hammond organ. I built Dynaco kits in college and Hafler kits in the 70's. My Hafler/Advent system of '79 was all the "Fi" I felt I needed.

One day at a friend's house I heard a Marantz 7C, 10B, 8B, Quad ESL system playing the Dellar Consort (Shakespearean songs). I wanted to go home and get my favorite records and just get lost. I was so impressed I became determined to purchase the same system. Finding the prices out of reach, I began to build my own. I bought books on speaker building, subscribed to Audio Amateur and began to read "Electronics Made Simple". I bought a Dyna MK-III and a PAS-3 and modified them. Now things were getting interesting.After building 3 way speakers with paper cones and Alnico magnets I designed my own EL-34 amp and bought a Super-It as a reference preamp. This system sailed through complex Mahler and loved John Lee Hooker.

At that time I met a man who would become my audio mentor. He had designed the best system I had ever heard. We worked out an arrangement: my Acro UL-II for his long term advice. I was given schematics to study and build. He preached pure triodes, low source impedance, high transconductance and no global feedback. Shortly thereafter, I met a gentleman that had been building amps since 1950. When asked if he had any advice regarding the design of a fine music system he had only this to say, "BELIEVE NOTHING YOU READ AND TRUST ONLY YOUR EARS".

1988 - After two weeks of listening to my first triode amp (6B4-G's) I put my EL-34 (triode connected) amp back in the system. A few records later I returned to the directly heated triodes. The difference was shocking. The EL-34 seemed artificial and "reproduced", lacking in weight and body. The triode amp was clear, direct, present and most of all VIVID.

Soon my mentor urged me to "take out the feedback." I was somewhat apprehensive. Certain that the quietness of my feedback amps would be lost and in its place there would be noise and distortion, I resisted. A month later curiosity got the best of me - I snipped the feedback leads. At first, all I heard was more gain and less noise. Two changes were obvious immediately after reconnecting the feedback.

First, feedback gave the sound a pronounced reverb quality I now recognize in any amp or preamp. It is a "phasey" effect that makes music sound canned and tends to distance the listener from the performance. Second and equally obvious was a loss of information and voice articulation. After listening to electronics *sans* feedback one instantly

wonders where the information went when one returns to feedback. It is a clean subtractive effect. "More feedback = less information" sums up my experience.

A system's strengths and weaknesses affect our listening habits and even our tastes in music. Whenever I listen to a new component I find myself going back to the record stacks in search of a record that will sound satisfying with the new component in the system. Therefore, one task is to design a system that likes as many types of music as possible.

Some of my most profound musical pleasure has come from my AM car radio. I always wondered why. On the other hand, I have heard more unlistenable twenty thousand dollar systems than I can count. This too stirred my curiosity. What makes a system plug into your heart?

If the music is strong it can come through an inexpensive system if the basics are correct. After auditioning systems of up to $250,000 I realized that the qualities which I had come to value were not available at high end salons. Also, I suspected that the reviewers promoting these systems might themselves be victims of cultural drift and had taken a wrong turn in the maze of sonic discovery.

What to do? I began to look backwards through audio history for the "fork in the road." As far as I can tell there is a break at the point when speakers got smaller and amps got bigger. At this point everything in the audio chain began to work harder and massive corrective measures were required. At a previous point we had high output (5-10Mv.) cartridge driving simple two tube (passive EQ) phono stages which in turn drove simple transformer coupled power amps into first order crossovers and very efficient horn speakers.

Less than one watt was sufficient to play any type of music in the home. Five tubes, two capacitors and one or two transformers *were* the signal path. The power supply was equally simple; tube/choke/capacitor or a simple pi filter. These few parts were operated in a narrow linear part of their range with 6-12 dB of headroom at each stage. A 109 dB/1 watt/1 m. speaker requires about .002 watt for satisfying home listening. Imagine what this does for the linearity of each stage of the audio chain.

Today we have parts counting in the hundreds and power ratings in the hundreds just to play chamber music in our studio apartments. The driver stage of a modern tube power amp is special if it has 3 dB of headroom driving any of today's audiophile speakers. That "edgy" sound you hear at your local hi-fi shop might be the equipment straining at its limits.

One should not assume that all vintage systems are better than today's best high-end systems, though some might be, but rather that elegant engineering, low parts count and maximum linearity/minimum phase were once the *only* way to design. Entire theatres were powered by fewer parts than those in a modern D/A converter. Not to mention the relative material quality or manufacturing excellence of these parts.

As my building and investigation continued, my mentor began to explore single ended amp design. He was using single 300B's for his mid range and single 2A3's for the tweeters. This time I did not hesitate. Using some Dyna ST-35 outputs I built a RCA-45 single ended amp. One watt. The sound was so direct, even at low volume, it brought tears to my eyes. As I turned up the volume pot, my home made speakers got the best of my amp. Anything above very low level listening drove the amps deep into grid current. I searched for more efficient speakers. My records, heart, and - most of all - ears led me to the 1940's vintage Altec system I presently use.

I bought some Tango transformers and built a 300B single amp just to hear for myself why the Japanese have enthroned this tube. I understood the reason moments into the first record. It has a texture and color in the midrange that is as rich as a painting. Comparing this amp to contemporary US tube products is like comparing Cinemascope or Technicolor to video.

My story is not about what plays music best. It is about my audio journey and the mindset which inspired it. I think that one shouldn't buy records because the sound on one label suits our system better than another. Instead, the system should accommodate a variety of material and encourage discovery. Exposure to new types of musical experiences can be an important part of learning to know ourselves. It can lead us to understand other arts (i.e. literature or painting). In my case the music led me to develop my understanding of electronics, math and physics.

What is sure is that there is a universe of recorded music out there and the methods of getting the music to your heart, feet and mind can and should be as distinctive as your own character. If your system produces a response of goosebumps, tears and laughter, if it stretches your soul, if it feels good, you will listen again and again. The music will stand.

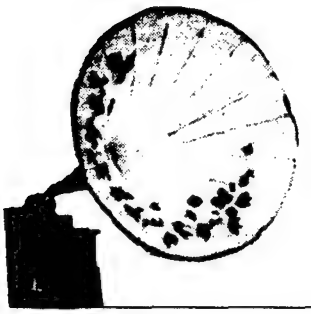
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Mono Mia !

by Vinny Gallo

I was born in the tragic slums of tragic Buffalo NY in 1961. I grew up there in an Italian-Black-Puerto Rican neighborhood. The Disco Superstar Rick James was my neighbor and is still good friends with my Uncle John or John "The Bull" Fantazzo, as he's known on the block. My family moved next door into my Grandmother's house when I was two, one month after my father was sent to jail. Don't ask. Anyway, he got out when I was 15 and threw me out of the house a year later on my 16th birthday. Don't ask.

I remember my Grandma's house. It was small and it had a smell, not a good smell or a bad smell just a certain smell. There was no TV, no radio - just this old wind up 78 machine with this big metal horn that had flowers painted on it. Underneath in a shelf, she had 9 records: three by Domenico Modugno- you know, the guy who wrote *Volare*, four Caruso records, and her two favorites - one by Dean Martin and one by my father singing "Fools Rush In". Before my Pops went to prison, he was a nite club singer. He got to record one single. If I think back, other than the fact that I hated her records, Grandma's windup machine sounded astoundingly good.

In the neighborhood, my Best Friend was this guy named Butchy, Butchy Megadino. His Pops was the biggest bigshot on the block. He was the biggest in the neighborhood, which to me seemed like the whole world. His name was Stefano Megadino. I say *was*, cause he was gunned down in front of Ray's Pizza Parlor in 1978 - 13 days after he joined Audiomart. He was the 13th guy to subscribe. Poor guy, he was so excited.

Mr. Megadino was tough and he worked hard to stay on top. But he would also spend a lot of time fooling with Hi-Fi. Mr. Megadino loved Modernization. He loved being the first to buy a new gadget and he always got his new Caddy first, or else! And he had the first and only Color TV in the neighborhood. I remember me and my Mother going over the Megadino's to watch Super Bowl III on COLOR TV. What a shock, COLOR TV! Everybody loved the Jets and that modern slickster, Broadway Joe. Everybody, except me. My hero was the simple conservative Johnny Unitas and the good-old-fashioned Colts. I cried when the Colts lost.

Mr. Megadino's biggest obsession was his Hi-Fi gear or *stereo equipment*, as it was called. And since I was like a son to him, I got to witness first hand the buying and selling of a lot of gear. I helped unload the first SAE 50 watt amp, the first GAS Ampzilla, the first Mark Levinson preamp. I loaded up Dahlquists, Magneplanars, Quads, KEF 103s, all of it.

Man, it was great - he was on top of the world. He had all the latest technology in the palm of his "black hand". Plus everytime he got something new, I could make a few bucks hooking it up for him. He refused to fix or connect anything. The guy would pay me to change the batteries in a flashlight. I still don't know if he *wouldn't* or *couldn't* do things like that. Anyway, his son Butchy was the same way. So they both needed me.

Mr. Megadino would always use one of his four copies of Tony Bennett's *Cloud 7* on Columbia featuring Chuck Wayne on guitar to show off any new gear. He had good taste. I was Hi-Fi HOOKED. Obsessed and in love with the stuff. Also during this time my hippy cousin, Asti Bunza, who was 18, was turning me on to all kinds of music. He had 24 LPs, the most of any kid in the neighborhood. He had every Beatles LP.

I was also spending a lot of time just going to stereo and record stores just staring and dreaming. Buffalo was a tough place for a kid to make a buck, especially in the early 70s. I had to really hustle. I had a bunch of contracts mowing lawns in rich neighborhoods and in the winter I would shovel a lot of driveways for a buck a driveway. I beat up this kid once who was stealing my customers with his gas engine snow plow. I also got 25 cents a day for lunch money, so right there I could save $1.25 a week, even though I was always starving. And I saved ever penny I made.

My friend Butchy was the opposite. He spent but he refused to work. He had a lot of habits to support - pinball, ice cream, candy, comic books, pot, and cigarettes plus a six pack every Saturday night. He was also a King Farouk with the girls. So he needed a lot of money. his father was generous to him but it wasn't enough. So Butchy became a thief, a BIG thief, a big FAT thief. It was OK with me because he stopped trying to borrow money.

One snowy Sunday morning after church, I went to Butchy's house and within 5 minutes he talked me into robbing the corner bar. It was called the Jolly Jug. Five days earlier, the owner bought some hi-fi gear hot, *very* hot, from a local junkie named Elmo Wright. Our plan was to get the hi-fi stuff and all the liquor we could carry out, so we used Vito Padulla's newspaper wagon for the job. Everything went smooth. The hardest part was divvying up with Butchy. We argued for an hour splitting up the booze. When we got to the hi-fi, neither of us would budge. We cut the stereo system in half. I kept one Dynaco MK IV amp and Butchy got the other one. I got the PAS 2 preamp and Butchy took the FM-1 tuner. We each got one A-25 speaker. The AR turntable fell out of the wagon and broke during our getaway so we left it behind in the snow.

In my Grandma's house, I slept on the couch in the living room. I didn't have my own room, so when I got home with my stuff I set it up in the basement. I already sold my share of the liquor to Frankie Bones at the Social Club at 220 Connecticut Av. He gave me two 20s, 40 Bucks. Forgeta 'bout it, I was rich! So the next morning I skipped school and went straight to my favorite stereo store. I needed a turntable to listen to my new system. I shopped all day checking out the latest and greatest and finally settled on a $75 Technics SL-20 with a $15 Grado P-mount cartridge. Total cost 90 bucks- the guy said if I paid cash no tax.

OK, now I had the 40 from the booze heist but that left me 50 short. I would have to spend 50 from my hard earned lawn mowing & snow shovelling money. Twenty five lawns and twenty five driveways - that was a lot of grass and a lot of snow. But I

couldn't get that SL-20 out of my mind. Those Japanese were geniuses at selling us pork eating Americans shitty good looking stereo stuff and between beef jerkys and bags of chips we were trading in our great old mono tube stuff to pay for it. Even the Italians did it. I was only 13 years old, how could I know? What's *your* excuse? The real funny thing is that old Technics and Pioneer stuff doesn't even look good anymore. It didn't hold up.

But that day I was thrilled and I rushed home and hooked up my half stereo system. One problem left- the Technics didn't have 78 speed and I had no records of my own. I had to use a 78 on 45 speed. I chose my fathers single and played it on 45. At 78 RPM, Pops was an OK song stylist, but in 45... MAN, he was singin' the *blues!* My pops just became a great Black blues legend in 45! But after a couple plays I was bored. Plus the Grado wasn't tracking 78s too good. I *needed* records.

Suddenly I got a flash, My cousin Asti Bunza the hippy got drafted and was getting ready to go in the Army. I heard he was selling his record, poster, and bong collection so I rushed over to make him a deal on the records. We settled on $11 and two joints that I found at the school playground about two years earlier. Besides, I had no need for that kind of stuff. I got all 24 LPs. He was a hippy and I was a happy. I went home and blasted all four sides of the Beatles' White Album. WOW! It was brilliant, trust me.

That was my first system and it was great and it was only one speaker and one amp. Unfortunately, that would be the last time I would be completely happy with my hi-fi system for years to come. What happened was I put the White Album away and ran over to Butchy's to try to try to buy the other amp and speaker from him. Unfortunately, Mr. Megadino wanted to buy my half. He was getting hooked on tubes again. Dynaco was his first setup and he was a sentimental guy. And besides his Ampzilla had blown up one too many times. I couldn't refuse the "Boss of Bosses" so I sold him my share of the stereo. But the guy did pay me very well.

Anyway that started a long period of buying and selling audio gear. I've owned it all- old stuff, new stuff , Levinson to Fairchild to Krell to Audio Research, back to old Marantz, then to Western Electric. Every amp, every speaker. All of it and for what? What did I get? A pain in the AASSSS. That's what. And why? Was it the equipment? My room? My records? *Me?* Forgeta 'bout it! I was OK, my records were the best, my room was beau-ti-ful, and some of the gear was good, especially the old triode amps. So what was the problem? Huh?

Think about it. Are mechanical and electrical reproducers supposed to take the place of live music? NO, they're not. They are what they are. They are their own thing. They have their own place in our lives and they shouldn't even be compared to live music. I really believe that great hi-fi should sound like the best radio you ever heard. Great hi-fi affects your ears and emotions in its own way, reminding you of sounds and sound impressions. For example take a photo of a chick that you love. It is not an actual reproduction - you can't touch or smell her. But you can get a strong emotional reaction from the stimulus of the photo. Some chicks even look better in photos and sometimes a simple black and white photo can be the most beautiful. Hi-fi works the same way.

Great Hi-Fi should sound like the best radio you ever heard.

Hi-fi is its own beautiful thing and for me the more simple it is the better. Mono, that's right, MONO. Ya heard me, MONOphonic. For years people listened to it and loved it. But some hustlers told us stereo was better while they were selling us two of everything. Well, it's not. Trust me. It might be more but it's not better.

Fortunately, one time I was stuck with only one amp and one speaker that I really wanted to wire up and listen to. Happens all the time when you try to put together classic vintage systems. Anyway, I tested them out and I was shocked. It sounded great! The gear was good but I realized that a big part of it was that it was mono. So pure, so simple, so beautiful. I never went back. It was like the first time I saw "Raging Bull", suddenly Black and White was hip again.

No more breaking my back to find two of everything, no more taking the whole room apart to fit in two of everything. Plus systems are half the price. And all the gear and many of the records I like were meant to be listened to in mono. Just try to get those big multicell horns to sound good in an average sized room in stereo, Not a chance. No longer did I have to sit in one narrow spot exactly between two speakers to enjoy the music.

Another great thing about mono is that it sounds right no matter where you are in the room. My system sounds great even from the next room or outside. My neighbors are always yelling up from the street, "Hey Vinny! That sounds Beautiful".

Mono, Mono, that's right, MONO MIA! Thank God. Less gear to fix, less wires. Stereo is a SCAM. How does dividing a recording in two make any sense anyway? What if you have a five piece band? What side does the fifth guy come out of? To me, the mono sound is perfect - coherent and whole. Stereo sounds like a special effect. Listening to stereo is like having to wear 3-D glasses every time you go to see a movie.

Many of the best records are mono anyway. There's so much great music recorded before stereo took over. And there are a lot of BAD stereo records around. Most of the time, they don't even get the special effect right. Good mono beats bad stereo everytime - just like good records sound better than bad CDs.

Stereo is like having to wear 3-D glasses everytime you go to see a movie.

I say most of you stereo equipment nuts hardly have time to listen to your gear because you're too busy shopping for special interconnects. Try this instead, set yourself up a simple mono system and listen to the music. Then you can share a pair of those special interconnects with your best friend. Keep it simple and have fun! If you shoot for the simple thing, you got a better chance of success. You might be surprised. Chew the fat, shoot the breeze, mull it over, think about it and give mono a try. Love, Vinny.

Whither Tubes . . .

by Eric Barbour

...the thermionic device and modern American civilization...

In making polite conversation with strangers, the subject of hobbies occasionally comes up. Now, most people admit that they lead rather ordinary lives. A few profess an interest in a specific hobby of some kind, as opposed to a general interest in outdoor activities and the like. Most of those hobbies consist of rather polite and traditional crafts: knitting, painting, model-making, ham radio, photography. But when I am posed the question in turn, things get weird in a hurry. I have to be honest, I tell them the truth: vacuum tube electronics. The response is predictable. Ordinary people give the mother of blank stares, then follow up with mumbled attempts to change the subject -- thus indicating their total lack of understanding.

A few people are "hip" to the idea of building and listening to tin boxes full of glowing-hot glass bulbs. Often these people are themselves into ham radio or some other electronic pastime. The rock musicians will always give out with this "it gives a real smooth sound man, good guitar amps use tubes too man" bit, while not understanding the reality of it in the slightest. And the people who make their living in electronics will give me a dirty look and mutter "what kind of crap is this???". And so the polite conversation veers off in another direction, dragged off by the person who initiated it. Even the older ones, who remember that thirty years ago tubes *were* electronics, shake their heads.

I pay no attention to them. After all, I am under NO obligation to explain it. Usually when I try, the blank stares just get blanker. Hell with 'em. Do I make light of adults who play with toy trains? There is no accounting for taste in one's amusement. Conversely, I feel no qualms about ignoring the critiques of others regarding my avocation. Even so, the reactions of others do inspire *some* thought -- here's an analogy that occurred to me recently.

PARALLELS

If you know anything about art, you will remember the biggest movement of the 1940s and 50s. It was called Abstract Expressionism. It was raw, dynamic -- distilled emotion on canvas. There was even a rough expression for it: AB-EX. Virtually all of its practitioners were men, and a more rugged bunch would be hard to find. Jackson Pollock. Robert Motherwell. Frankenthaler. Stella. Whether they splashed, dribbled, or poured their paints, they did it with abandon. And they believed in abandonment in their lives. Many were classic "two-fisted drinkers".



Franz Kline, *Cupola* 1958-60

They didn't care about society, about the rich people who bought their works. They could be found pissing in fireplaces, smashing furniture. To hell with refined sensibility -- art was PASSION. AB-EX was MANLY, in a culturally sanctioned, almost traditional way.

Is it any wonder that the same period, 1945 through 1959, was the Golden Age of high fidelity? It was a time when tubes had magic, when sound was a dynamic living art. Of course, it was a bit *too* dynamic; it had to change.

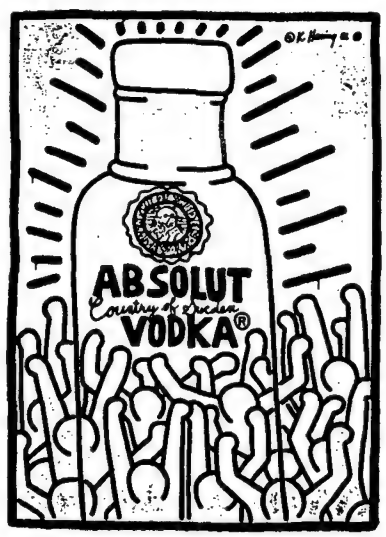
So then came the Sixties...
Pop Art. Warhol. "The English Invasion".
Tiny Tim.
Transistors.

With the imperial rise of the transistor, the Americans who dominated the world of High Fidelity -- Saul Marantz, Avery Fisher, Norman Pickering, David Hafler, and many others -- gave way to new, strange names: Sansui, Sony, Matshushita. The "giants" faded away, sold out to the "Shining Solid State Future".

The hard economic facts simply caught up with them. As the AB-EXers were ignored away by the ever trend-obsessed art establishment, the money gravitated toward the Pop world and its fascination with advertising and publicity. The honest and raw lost out to the shallow and user-friendly. Truth was too ugly so it was veneered over with a superficial, self-regarding phoniness. The American Empire, after peaking in the '50s with the greatest period of prosperity in human history, began its slow and erratic decline.

The merchandizing of culture reached full speed in the Seventies, a period of sexual hedonism and cocaine, the neurotic's drug. Where the cultural prophets of the '50s experimented with marijuana and opiates, inward looking drugs, the '70s and '80s were a time of greed and popular use of stimulants like cocaine and amphetamines.

During this same period, the Art World started capitalizing its name. The new prophets were the shallowest of all: Hockney, Haring, and especially Kostabi. Not artists at all but cartoonists, little boys who snubbed AB-EX and embraced the Almighty Dollar like no artists in American history ever had before. Their "art" was produced and reproduced as a pure commercial product on a worldwide basis.



Keith Haring, 1986

The metamorphosis of the audio market during the '60s and '70s mirrored the shifts in the art scene. What started as a small, grass roots industry run by and for enthusiasts became a mass market, run by faceless accountants in Tokyo.

RETURN OF THE IRRATIONAL

In spite of the grim mechanics of the market, tube amplifiers have been increasing in popularity. Even while GE, RCA, and Phillips/Sylvania were dismantling their vacuum tube production facilities, audiophiles in the know were looking for tube amplifiers. The seminal cause of this resurgence of interest was the appearance in 1989 of a magazine about tube audio: *Glass Audio*. Along with it came a frenzy of activity in the small market for vintage hi-fi equipment. The number of small companies that manufacture new tube equipment for the specialist audiophile also started to increase, and has continued to do so. Yes, it's irrational, but then, so is music itself. And, by the way, there has also been a resurgence of interest in Abstract Expressionism.

Owning an ordinary solid state stereo system is like owning any other household appliance. Every Joe Consumer has to have one - even if he doesn't use it much. The "stereo", usually Japanese and always full of cheap, convenient transistors, is an appliance like the microwave oven: easy to use, stable, the electronic buddy. Part of the glory of technology for Joe is that Science Makes Life Easier; his motto, "Give me convenience or give me death."

Nothing in the American household is less rational and less convenient than a vacuum tube stereo system. Modern tube gear is expensive compared with solid state "air boxes" that can produce the same "amount" of sound. Tubes need lethally high voltages, they produce vast amounts of waste heat, they wear out and must be changed every few thousand hours. Tube systems require personal involvement and they require dedication since the old support system for the technology is vanishing. Not good, not easy like an appliance. In short, inconvenient. By the conventions of Rational Middle America, tubes are bad.

Then why are there 100+ companies making tube equipment today? Why do "relics" like the Marantz 8B sell for many times their original retail prices? Any why do audiophiles continue to get excited about tubes? Despite the inherent advantages of tubes in amplifying music, it's not a rational thing, just as AB-EX was not a rational art form by any definition.

Although tube amplifiers are owner-maintainable, electronically simple, and electrically rugged, they have a certain abandon, a tiny edge of madness. Although they are no more likely to go berserk than transistors, tubes are INTENSE. Being a very large, hot, glowing thing, a tube amplifier has a certain kinesthetic power that no semiconductor amp can simulate.

Audio as we know it is a male-dominated hobby. Surely women own stereo equipment as widely as men do. But to be *obsessed* with it is something that males pursue, typically with a bit of that AB-EX abandon. Let's face it, audiophilia is itself an extreme pursuit, but it has its own ultra radical element -- devotees of the vacuum tube. There are not many women among this group.

It's not as though listening to tubes takes male ears. It's not that men can hear better than women (in fact, the opposite holds true). And it has nothing to do with the phallic shape of the tube. What is operating here is a masculine kind of cultural bias; tubes require the user to take a chance, to brave the heat and the voltages, to accept the challenges. Tube audio resonates with the roles society defines for men, "man the hunter", "the tool maker" and "the risk taker". Because of this bias, tubes are seen as having no place in the domain of women "the child-rearers and homemakers".

The perceived maleness of tubes is a social and cultural depiction that has little to do with reproducing music. As tube equipment continues its rise in popularity and becomes less of an "ultra-radical" technology, perhaps it will lose some of that cultural baggage and be appreciated for what it is - not a nostalgia trip, not an eccentric pastime, not a test of one's seriousness as an audiophile - an important part of a vital hobby, an instrument of pleasure in the art of listening to music.

Eric Barbour has been an audio hobbyist since college days in the late '70s. He has a BSEE degree from Northern Arizona University. He is the president of the Great Basin Audio Society of Reno, Nevada, a contributing editor of *Glass Audio* magazine, and the owner of Metasonics, a mail-order maker of electronic kits for audiophiles. Contact Eric at 552 McCarran #284, Sparks, NV 89431. (702) 358-2019.



W.A.F. *by Joyce*

Guerrilla Tactics for the Audiophile Home

The first time you find him in the kitchen wearing your frilly apron and baking a newly spray-painted amp chassis in the oven you think it's kind of cute. You keep an open mind despite the fumes and try to sympathize with his need for a hammered metal look finish. Then on a dark night you stub your toes on that same chassis lying in the middle of the living room floor and you think, Not so cute.

Might as well face the truth. For every audiophile in the world, there's an afflicted spouse, housemate or friend. And, sooner or later, we all must learn the guerrilla tactics necessary for survival in the audiophile home.

Be Quick on the Offensive

Your favorite sewing scissors have once again mysteriously disappeared. You must confront him immediately. And remember, please, none of this wimpy you-wouldn't-happen-to-have-seen-my-scissors-anywhere type stuff.

She: "I want my sewing scissors back now." Place hands on hips and sigh deeply.
He: "What sewing scissors?" (puzzled look)
She: "Those sewing scissors." Point in general direction of work bench.
He: "Oh, those scissors. You know what those are great for?" (sheepish grin)

Never mind. Grab those scissors and head for the door.

Never Call a Part by its Name

You find yourself staring at an amazing jumble of audio parts piled up in the middle of your bed. You see capacitors, resistors, vacuum tubes and scary looking surgical stuff. You want the mess off the bed, but now remember, never refer to audio parts as anything but "parts". Forget the fact that you've tried to learn their individual names. When the time comes to put your hard-earned knowledge to use, you will invariably get them wrong.

She: "What's that transformer doing in the bathroom sink?"
He: (with a superior smile) "That's not a transformer, that's a high-voltage 6B7 for my 12K9."

Keep 'em on their Toes

It's Saturday night and the two of you are enjoying a quiet evening at home. You've got your slippers on and the tubes are glowing warmly on the latest amp. After weeks of tinkering and tweaking, the new amp is finally being inaugurated.

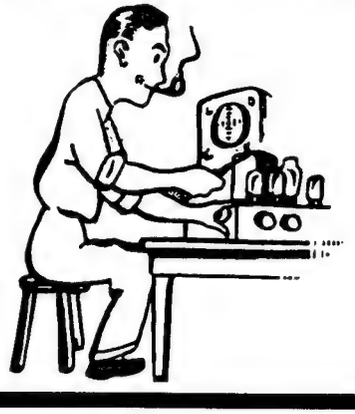
Your man is now sitting in the exact center of the couch, eyes closed in concentration. He turns his head slightly to the left, listens, jumps up and adjusts a knob. This goes on for a while. Eventually, the fine tuning subsides and a peaceful expression comes over your spouse's face.

This is your moment.

She: "What's that humming sound?"
He: "Huh? What humming? You hear a hum?"
She: "Well, I'm not sure, but just then when I walked past that speaker I thought I might have heard something like a hum."

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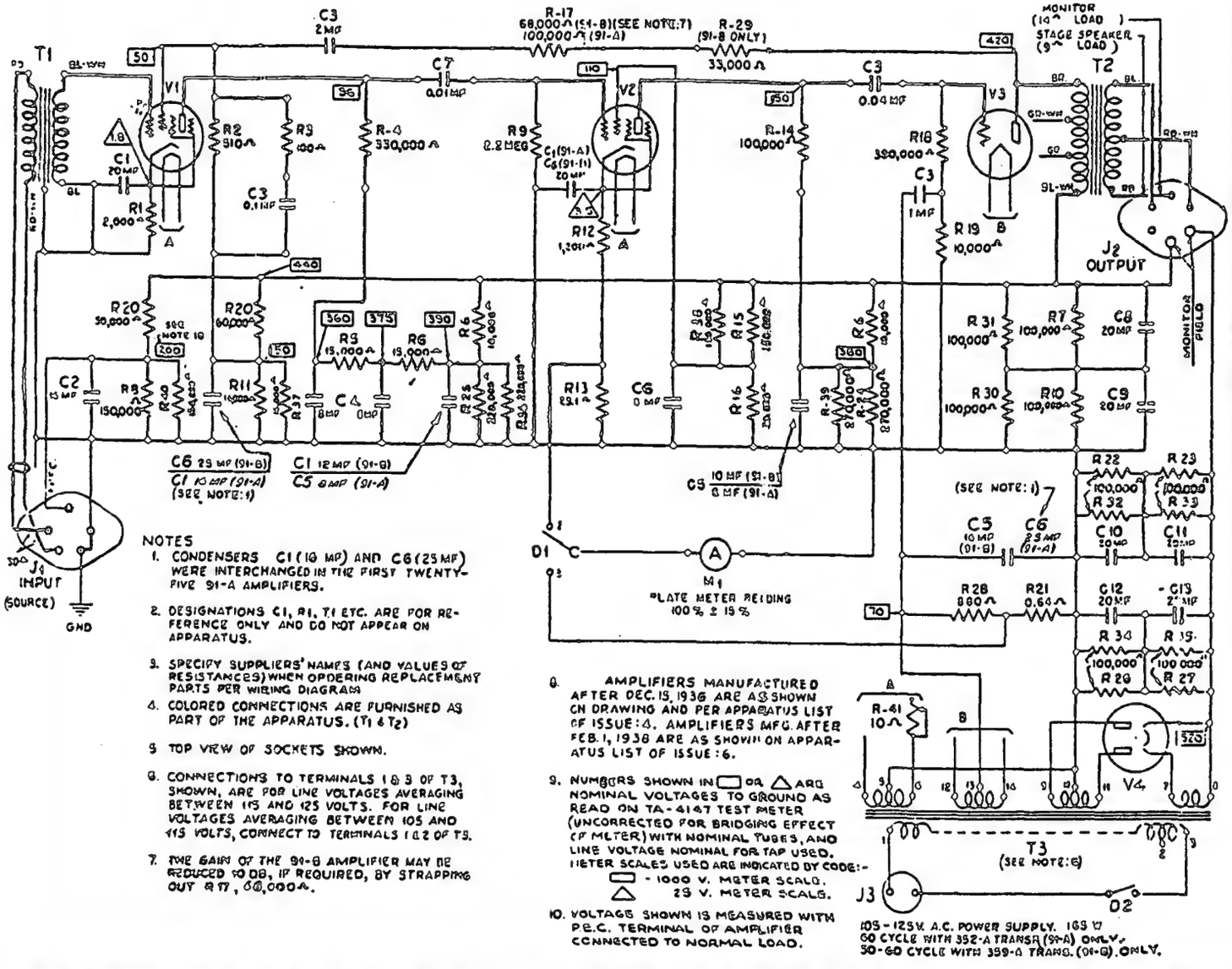
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703-836-4382 voice/fax

Western Electric

No. 91-A AMPLIFIER



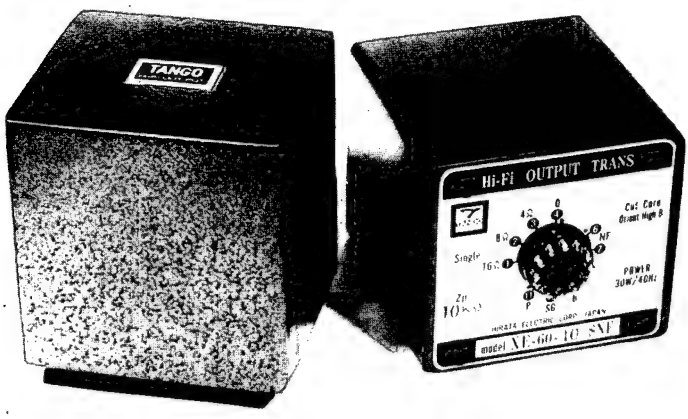
NOTES

1. CONDENSERS C1 (10 MF) AND C6 (25 MF) WERE INTERCHANGED IN THE FIRST TWENTY-FIVE 91-A AMPLIFIERS.
2. DESIGNATIONS C1, R1, T1 ETC. ARE FOR REFERENCE ONLY AND DO NOT APPEAR ON APPARATUS.
3. SPECIFY SUPPLIERS' NAMES (AND VALUES OF RESISTANCES) WHEN ORDERING REPLACEMENT PARTS PER WIRING DIAGRAM
4. COLORED CONNECTIONS ARE FURNISHED AS PART OF THE APPARATUS. (T1 & T2)
5. TOP VIEW OF SOCKETS SHOWN.
6. CONNECTIONS TO TERMINALS 1 & 3 OF T3, SHOWN, ARE FOR LINE VOLTAGES AVERAGING BETWEEN 115 AND 125 VOLTS. FOR LINE VOLTAGES AVERAGING BETWEEN 105 AND 115 VOLTS, CONNECT TO TERMINALS 1 & 2 OF T3.
7. THE GAIN OF THE 91-B AMPLIFIER MAY BE REDUCED 10 DB, IF REQUIRED, BY STRAPPING OUT R 17, 60,000Ω.
8. AMPLIFIERS MANUFACTURED AFTER DEC. 15, 1936 ARE AS SHOWN ON DRAWING AND PER APPARATUS LIST OF ISSUE: 4. AMPLIFIERS MFG. AFTER FEB. 1, 1938 ARE AS SHOWN ON APPARATUS LIST OF ISSUE: 6.
9. NUMBERS SHOWN IN □ OR △ ARE NOMINAL VOLTAGES TO GROUND AS READ ON TA-4147 TEST METER (UNCORRECTED FOR BRIDGING EFFECT OF METER) WITH NOMINAL TUBES, AND LINE VOLTAGE NOMINAL FOR TAP USED. METER SCALES USED ARE INDICATED BY CODE:-
   □ - 1000 V. METER SCALE.
   △ - 25 V. METER SCALE.
10. VOLTAGE SHOWN IS MEASURED WITH P.E.C. TERMINAL OF AMPLIFIER CONNECTED TO NORMAL LOAD.

DESIGNATIONS		APPARATUS
91-A	91-B	REPLACEMENT PARTS
C1	——	AEROVOX 8-20-20/25V, 16/100V COND
	C1	" 8-20/25V, 12/500V COND
C2	C2	" 8-18/400V COND
C3	C3	315Δ CONDENSER
C4, C5	C4	AEROVOX 8-8-8/475V CONDENSER
——	C5	" 8-10/500V, 16/100V COND
C6	——	" 8-25/200V, 8/300V "
——	C6	" 8-25/100V, 8/200X20/75V "
C7	C7	2300 CONDENSER
C8, C11, C13	C9, C11, C13	AEROVOX 8L-20/500V CONDENSER
C9, C10, C12	C9, C10, C12	" 8-20/500V "
D1	D1	H B H 21350 SWITCH
O2	O2	H B H 20992 "
J1	J1	AP-1570-5 SOCKET
J2	J2	AP-1570-6 "
J3	J3	H B H 754 MOTOR BASE RECEPT
M1	M1	NO. 7600 METER
R1, R2 R11, R18, R19, R 5-017, R37, R38	R1, R2, R11, R12, R19-R17, R37, R38	AO TYPE HO-2W-5% RESISTOR
R3-0., R7-R10, R14, R16, R19, R23-R27, R30-35, R39, R40	R3-R5, R7-R10, R14, R16, R19, R23-R27, R29, R30-R36, R39, R40	" " " " " "
R6	R6	IRC PW 349-35,000Ω TAPPED 15,000, 10,000 10,000 TYPE 2 TERM
R13	R13	63ES RESISTANCE
R20	R20	IRC PW 347 SPEC. 140 OHM 4 WATT 110,000Ω TAPPED 50,000 TYPE 2 TERM.
R21	R21	63ES RESISTANCE
R28	R28	WL TYPE 1"D 880Ω 200 TERMS
R41	R41	WL 25A 10Ω 25W ADJ. 796 BIGS
T1	T1	285Δ TRANS
T2	T2	TW 222 "
T3	T3	TW 608 "
V1, V2	V1, V2	606 VACUUM TUBE
V3	V3	3000 " "
V4	V4	874Δ " "

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Eddy Electric will provide schematics, design assistance or complete installation with these units. Please write for our literature ($2.50) which includes transformer specs, and schematics for push-pull, single ended, and transformer coupled amplifiers. We especially recommend the CRD-5 for triode connected EL-34s and tthe FX-45-5 for UL and pentode connected DYNACO STEREO 70s.

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Model	Watts	P. Imp.	Frequency Response	Application	Price/Ea.
X-5	120	5/3.5K	4Hz~100KHz -1db	300B, KT-88, KT-66, EL-34, 6L6CG,	$575.00
XE-60-3.5	60	3K	4Hz~100KHz -1db		$349.00
XE-60-5	60	5K	4Hz~ 80KHz -1db		$349.00
XE-45-5	45	5K	5HZ~ 70KHz -1db	EL-34, 6L6GC, 2A3, 6B4G,	$235.00
FX-40-5	40	5K	4Hz~ 80KHZ -1db		$149.00
CRD-8	25	8K	10Hz~ 60KHz -1db	KT-66, 6L6GC, 6V6, 6BQ5,	$129.00
CRD-5	25	5K	10Hz~100KHz -1db	EL-34, 6L6GC, 2A3, 6B4G,	$129.00

SINGLE ENDED S. Imp, 4Ω, 8Ω, 16Ω,

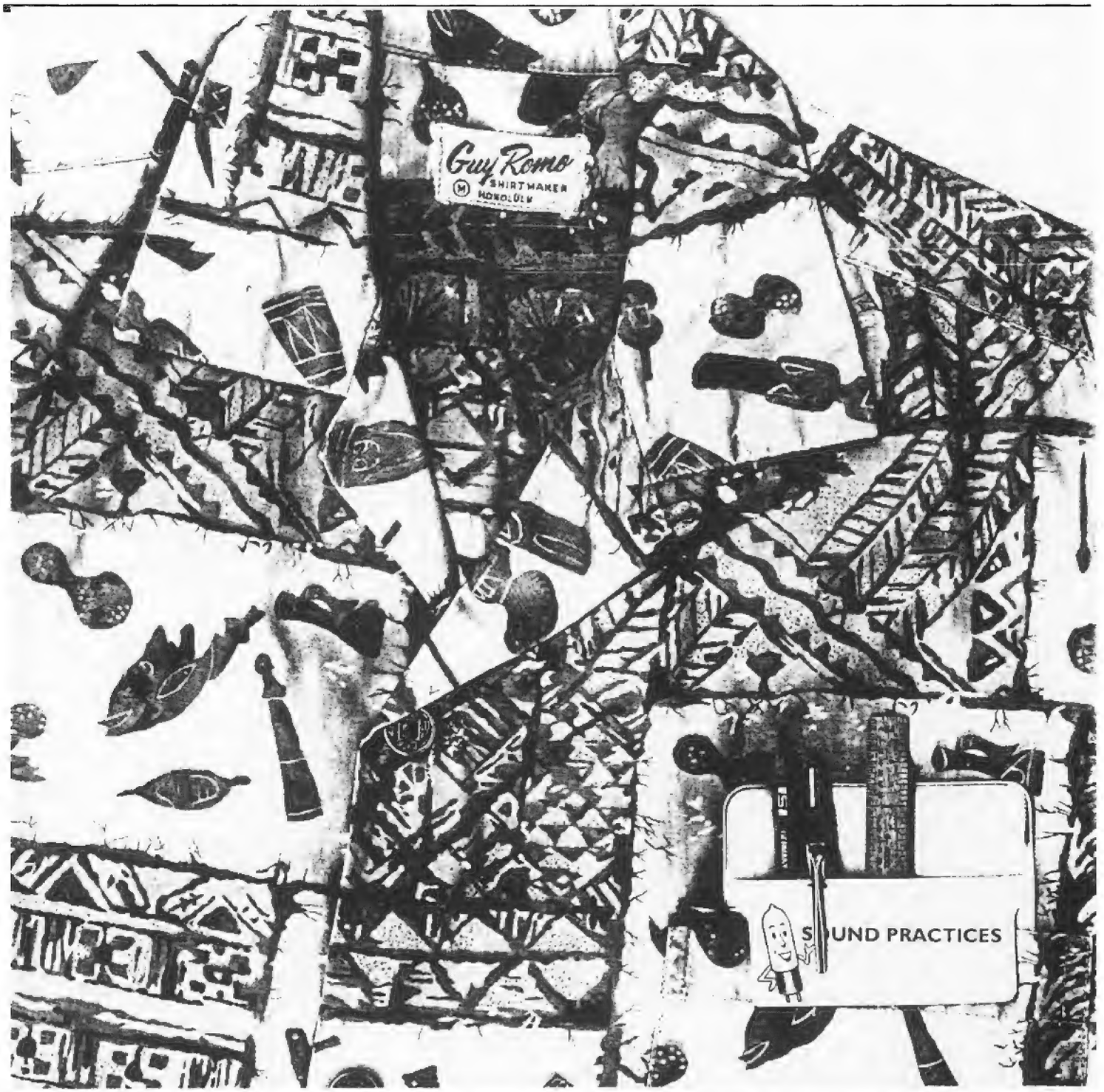
Model	Watts	P. Imp	Frequency Responce	Application	Price/Ea
X-5S	40	5K	18Hz~ 70KHz -2db	300B, 50,	$635.00
XE-60-3.5S	60	3.5K	20Hz~100KHz -2db		$335.00
XE-60-10SNF	30	10K	30Hz~ 50KHz -2db	211, 845,	$349.00
XE-50-3.5S	30	3.5K	25Hz~ 80KHz -2db	300B, 50,	$275.00
XE-20S	20	5K	35HZ~ 75KHz -2db	300B, 50, VT-52, 2A3, KT-88, KT-66	$225.00
		3.5K	25HZ~ 90KHz -2db		
		2.5K	20HZ~ 80KHz -2db		
FW-20S	20	5K	50HZ~ 70KHz -2db	300B, KT-88, 2A3, 6B4G, EL34,	$175.00
		3.5K	35Hz~ 80KHz -2db		
		2.5K	25Hz~ 90KHz -2db		
U-808	20	5K	50HZ~ 50KHZ -2db	300B, EL-34, KT-66, 6L6GC, 7591,	$ 99.00
		3.5K	35Hz~ 60KHz -2db	7189, 2A3, 6B4G, VT52, 71A,	
		2.5K	25Hz~ 65KHz -2db		
		2K	20Hz~ 65KHz -2db		

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SOUND PRACTICES

A JOURNAL OF AUDIO TECHNOLOGY FALL 1992 FIVE DOLLARS



New Sonic Fashions Issue Vol 1: #2

Sound Practices

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Sound Practices actively solicits contributions of written material of interest to our readership. Please contact us to discuss your ideas. We are open to articles on all sound practices.

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. . . AND MUCH MORE !!!

A matter of CHOICE

The vast range of audio technology developed over the past 80 years is one of our century's gifts to humanity. And it's the best kind of gift there is: the kind you are free to accept or decline according to your own lights. However, REAL free choice requires looking at *all* of the alternatives - past, present, and possible. There is a tremendous array of options in audio, especially if you don't limit yourself to the products advertised in last month's *High End Rag.* I am sure many people took one look at *Sound Practices* #1 and concluded that it wasn't for them. True, *Sound Practices* is surely not for everyone. *Sound Practices* is about expanding the boundaries of the discourse. Some seem to like things alright just as they are.

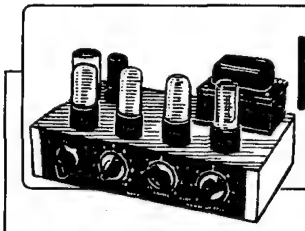
In this age of technical passivity, the appearance of schematics and (*heaven forbid!*) equations will scare off many casual readers. Hope you at least think it over before you retreat. Aside from undergoing an interesting learning experience for its own sake, you can radically expand your *practical* options as you acquire enough technical know how to build your own equipment, modify units to your preferences, and maintain "obsolescent" gear. In an age when most are content to choose from a fancy display of hermetically sealed appliances, your soldering iron and your library are powerful weapons of free choice. With a bit of knowledge and brainpower you can do some serious damage to the "appliance consumer" mentality.

Unbelievable that "back in the day", you could actually learn practical audio electronics by reading the newsstand Hi-Fi magazines. *AUDIO* in 1992 won't get you there the way *AUDIO* did in 1955 or the way *RADIO NEWS* did in 1945. The strict division between producers and consumers inherent in today's marketplace is reflected in the typology of contemporary audio magazines: in general, either you get a glossy "Buyer's Guide" or you get a dense journal you have to be a rocket scientist to hack through. The middle ground is the most valuable territory for many of us and that's where *Sound Practices* will set up camp.

You will probably find a few statements which will alienate some hyper-fi types. Sorry, Audio as practiced by devotees of the Cult of the High End is NOT the only legitimate form of *serious* audio experimentation. Many of the most perceptive audiophiles I know don't read *any* of the High End mags. Of course, you don't hear much about these people because they haven't had a magazine to champion their causes. Not much commercial potential in folks happy with "old" gear and DIY stuff. They are "invisible audiophiles" but some of them are at the leading edge of audio experimentation. A few are even dangling *over* the edge!

High End Audio as propounded by the Gurus is a strict and dogmatic discipline. Although the tendency is not to see it that way, a very narrow aesthetic guides the subjective review process. Words like "neutral", "accurate", "detail" are loaded terms which carry a lot of ideological baggage. Whaaat? How can you be a *serious* listener and not want *more* detail? Or more of that dry, analytical NEUTRAL presentation? Or a more UNCOLORED sound? Some gear is even so uncolored it offers far less color than music itself. If you're a detail freak there are a few products out there that will give you a sense of more detail than ever graced the stage. The point I'm trying to make is don't buy it just because THEY say it's good, decide for yourself. A lot of the high end stuff images great but you can forget much of it if you wanna boogie down or bop out.

(continued p. 2)



NEW PRODUCTS

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The Impulse loudspeakers, horn loaded designs greatly favored by certain members of the audiophile press in the UK, are represented in the US market by importer Renaissance Sound. There are three models available - retail prices start at $1995. Dealer and end-user inquiries invited.

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THE BOOK ON WESTERN ELECTRIC TUBES

Antique Electronic Supply has just released ***75 Years of Western Electric Tube Manufacturing***, a 140 page book which describes and pictures over 750 WE tubes in a handy numerically organized format. The author, Bernard Magers, was a Senior Engineer at WECO involved with tube production at the Kansas City Works, final home of the 300B. A brief historical overview of manufacturing at WECO, a summary of tube manufacturing notes, and a useful bibliography are provided. Magnetrons get more coverage than audio tubes but the serious student of vacuum tube technology will find this $16.95 volume to be a worthwhile investment and a valuable addition to the literature on the subject.

ANTIQUE ELECTRONIC SUPPLY
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CHOICE (continued from page 1)

The preferences legislated by the High End Gurus are adopted by many, sometimes consciously and with intelligence but often without perspective or prior reflection. We all know hard-core audiophiles who listen ONLY to Reiners and Mercury Living Presences on Editor's Choice gear. Sure, I'm glad I heard *Casino Royale* on Jeff Rowland electronics and Infinity Betas, but I must say I had a mo' better time listening to Hank Williams 78s on Western Electric speakers and some very scary looking homebrew electronics. Never was a big Herb Alpert fan. Joining in the grail quest of audio writers best known by their initials is engaging I suppose but it's no cause for snobbery and exclusionism. And it's definitely not the last word. There is no last word in this game. Audio is about *your* preferences and *your* tastes, or at least it should be.

The aesthetic foregrounded by High End pundits becomes an important element in the design equation since manufacturers have to impress this group to survive. The High End reproduces itself in this manner. What we got here folks is *sonic fashion*. Parts, circuit topologies, and more fundamental factors like the choice of media or encoding systems all help define the "in thing" in sound. You can step out of the parade anytime you want - no need to wait for the Recommended Components List to lead the way.

There is an internal contradiction in the High End dogma that reproduction must be scrupulously evaluated in comparison with a utopian ideal of "live unamplified acoustic music." Focus on such an impossible goal encourages preoccupation with what is wrong with the system. Why not turn it around and look at what a system does well? How can you listen for failings and enjoy whatever you're hearing? No wonder so many enthusiasts burn out on *audio* and retreat to the happy pastures of music listening. Attitude is more instrumental than hardware in the pursuit of musical enjoyment.

Even at its best, reproduction is illusion, in short, a LIE. Should audio be reduced to a quest for the best liar? Maybe. Why not pick a fibster with a style you find personally convincing. Learn to appreciate the particular style of deception the masterful con artist brings to his craft. Suspend disbelief and journey ahead. Accept that you'll never get the absolute musical truth out of a pile of parts and wire. Let the Audio Priests pursue the impossible goals. Let the rest of us make our own choices.

As I see it, the major challenge faced by *Sound Practices* is to promote alternatives without falling into its own predicable routine. Sure, there is a dire need for discussion about single ended and triode amps - if only to fill in the gaping void in the English language literature. But I recognize that not everyone shares my undying passion for 10 pound per watt amps. This stuff can get as boring as Dynaco mods with prolonged exposure. (Well, almost).

Come on, even the most dedicated tube freak must admit that transistor amps have come a long, long way and can equal tube gear in overall quality, even if our subjective preferences lie with our trusty "hollow state" gear. So let's keep the discourse wide open. If you've had it with WWII-era triodes or whatever, let me know. Better yet, consider sharing *your* hard earned insights and sonic achievements with your fellow readers. *Sound Practices* - like everything else in your audio life - will be exactly what you make it.

Art at the Edge of Science

The sonic explorations of Kondo-san

by Joe Roberts

Audio experimenters have uncovered many gaps in the models textbook science brings to bear on electro-acoustical phenomena. This can be a source of bafflement and embarrassment to authorities in the field, but our ears have proven their value as a most subtle evaluation device - one which hears things that *can't* be there. Many scientists take the comfortable and logical way out and deny the possibility of unmeasurable "new" audio phenomena.

For example, in the Spring 1991 issue of *The Skeptical Inquirer*, Fred E. Davis gave us "Hi-Fi Audio Pseudoscience," an article committing cables, AC cords and conditioners, CD treatments, and novel uses for digital clocks to the shady realms of mysticism and the powers of suggestion. He doesn't claim to have done much listening. Surely not worth the trouble based on mathematical models. Yet most of this study was based on "skimming through three or four audio magazines." Very rigorous method indeed!

As audio experimenters realize, there are other ways we can "know" aside from formal scientific research. There is a distinction between "*knowing how*" and "*knowing that.*" Both ways of knowing are achieved through an empirically based trial and error process. The difference is that *knowing that* doesn't have the same dependence on an explanatory model. We can recognize what happens and even learn to predict what is going to happen without understanding the "mechanics" of the process. "Discoveries" can often be put to good use without understanding *how* they work.

Before science was appropriated by large institutions like universities, government research facilities, and industry "think tanks", the independent inventor was the main agent of scientific discovery, often relying on inspiration and trial rather than theory to guide their experiments. Much of the interesting work in audio is still done this way.

Informal exploration in audio is not governed by the strict etiquette of white lab coat science. Nowadays there's no grant money available to research exotic claims in high end audio so don't expect much attention from BIG science. Progress in audio is a challenge for underfunded, imaginative, and independent experimenters to address on their own terms, often in their own basement or listening rooms.

The range of experimental strategies that have been applied in high end audio defies summation. Investigators span the range from "new physicists" like Peter Belt and George Tice to material hackers who spend weeks listening to interconnects made from different kinds of solder. Iron bricks, demagnetizers, tuning dots, lead bars, wires, air bearings, precious metals, contact enhancers, spikes, green pens, carbon fibers: the conceptual variety of tweak experimentation is staggering. You really have to stop and wonder where the inspiration for some of these experiments arose.

All hype, politics, and mysticism aside, if you've been experimenting you know that some very "unlikely" treatments can change the sound you hear. Usually you get *different* rather than *distinctly better*. But there is often a real effect, sometimes subtle and sometimes profound. In time, products we all laughed about at first, like "special wire," show up on the shelves at Radio Shack.

All over the world, the appreciation of classic audio gear for its historical, sonic, and fetish value is growing. At the same time, designers are reevaluating long abandoned technologies like triode output stages, single ended amplifiers, and horn loaded speakers with well trained modern ears. Even though it has been done before, new realizations are emerging this time around. Turns out that some things we all thought was junk can sound great and vice versa. Concepts of progress are being reevaluated and textbooks haven't caught up yet.

As long as theory lags behind practice, audio artists will constitute the leading edge. Some of the best students *are* trained scientists and real engineers. But the most vital arena of investigation lies a bit beyond the edges of science.

THE QUESTION OF STYLE

Audio Note's Hiroyasu Kondo, like other great audio artists, gives us a family of designs with distinctive vision and *style*. Kondo's peer group is the Japanese Ultra-Fi audio culture. A product like a single ended 211 or 300B amp is fairly typical in Japan, where appreciation of classic audio technology is highly developed. In the States, such products are still so far out they elicit blank stares from most audiophiles. Viewed in its native context, the work of Kondo-san reflects a conventional style but it incorporates a powerful personal statement on the art and science of audio worldwide.

The extensive use of silver is one hallmark of an Audio Note creation but there are other stylistic features which point back to the hand of Kondo. For example, he uses certain tube types across the entire line and they reappear like signature riffs in a blues tune. The 6072A is usually the low level tube, the driver is typically a 5687. Output tubes are drawn from the directly heated triode family - 211, 2A3, and 300B. Most of the tubes Kondo employs are audio classics or highly specified military/industrial bottles well qualified for the task. The 6072A, for example, is listed in the RCA manual under "Premium Tubes - designed to meet military specifications and critical industrial applications." What more critical application exists than a $60,000 amplifier? Kondo's preferred tube lineup appears not only in the Audio Note amplifiers. The M7 tube preamplifier also relies on, you guessed it, 6072A s and 5687s throughout.

Kondo uses different tubes in each stage in different configurations to avoid additive distortion and to cancel the kinds of distortion each stage introduces. This is said to be a Japanese high end group style technique. Kondo-san's personal style seems to be an SRPP (series regulated push pull) 6072A input stage direct coupled to a 5687 voltage amp, then cap coupled to a 5687 cathode follower driver for directly heated triodes.

Every component of Kondo's products gets special consideration. He hand rolls silver foil oil caps and prefers custom tantalum film resistors - said to offer a degree of grainlessness that no other resistor can match. Audio Note specifies special order units with silver leads and end caps! His circuits are built around luxurious silver wound output transformers and solid copper chassis. Kondo-san's sonic artistry is in realization as much as design.

SILVER

In the USA, the audiophile community is strongly divided on the issue of silver wire. Some love it and others hate it. The usual lack of solid theoretical grounding applies here. True, silver is a slightly better conductor than copper but not by enough to really matter in terms of resistance. The question of the sound of materials is a cloudy area conceptually but one which has proven to be very important in practice.

The best answer I got on why silver might sound so good came from Randy Bradley at Bear Labs, a maker of well-regarded silver cables, who offered "Nobody knows *why*, but *when properly applied*, it does." Kondo is said to be carrying out experiments in hopes of determining why silver sounds the way it does. In a way, this study is purely academic. Whether he finds out or not, the cables will still sound the way they do. The sound is what matters.

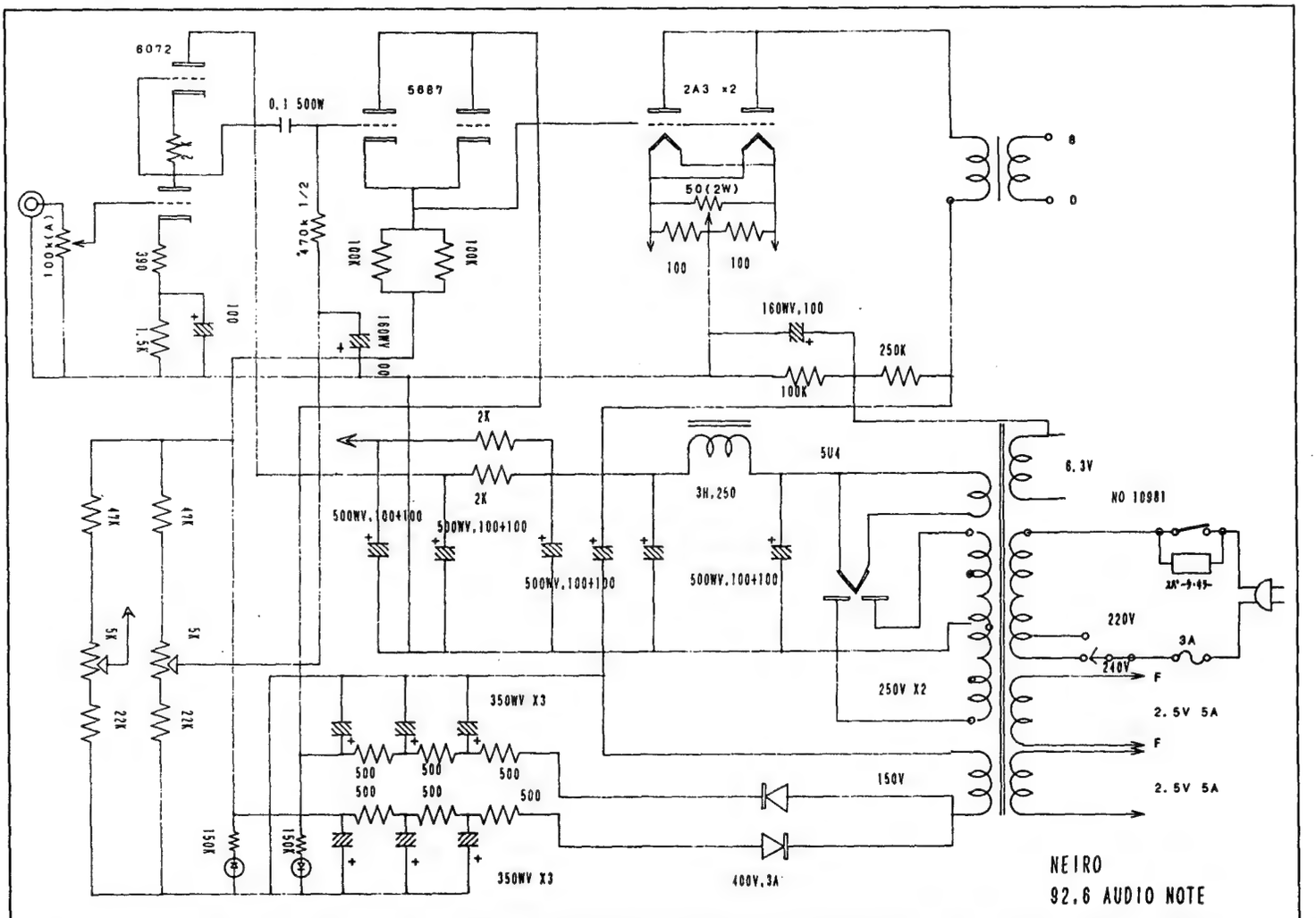
As with all wire, success with silver has to do with cable topology and system matching. It's not something to be used randomly. Audio Note promotes a well reasoned systems approach to the use of silver: the best thing to do is to use silver everywhere. Disjunctions between metals should be minimized for best sonic results. If only partially cabling up with silver, it is best used up front, they argue, since 'copper distortions' will be rendered more obvious by silver downstream. Systems with problems like poor contacts and inferior wire elsewhere, should avoid AN silver since it will disclose any prevailing weakness in the system.

Audio Note claims that some combinations of copper wire with AN silver can result in a substantial increase in high frequency response and occasionally loss of lows, causing the system to sound too bright. This is the classic critique of silver wire. Maybe the sin of silver is *disclosure* not *commission*.

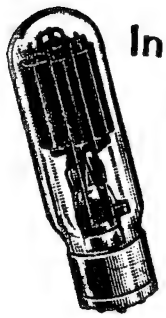
All silver is not equal, most audio silversmiths would claim. Audio Note silver is not your usual off the shelf silver. It is high purity (99.99%) although other silver cables are more pure (e.g. Kimber @ .99999). AN silver is imported from Italy and specially processed from ingots at the Tokyo plant. It is cold drawn through a diamond die and immediately coated with several layers of polyurethane to forestall oxidation and mechanically dampen the surface of the wire to prevent "wire crying". Audio note argues that even tiny amounts of surface oxidation cause sonically detrimental rectifying effects which negate the advantages of AN silver.

In the Audio Note UK literature, AN silver cables are claimed to be their most "important product." In Kondo's article which follows, he seems very impressed with the aural qualities of silver wire and enchanted with the sound of his hand rolled silver foil oil caps and his custom silver wound output transformers. Silver is the heart of Audio Note. Unfortunately, as Peter Qvortrup of Audio Note UK observes, "Using the purest available silver as a conductor, naturally has the same effect on price as it has on sound quality: it is automatically high."

TO BE CONTINUED NEXT ISSUE



The Audio Note *Neiro 7.5W* parallel single-ended 2A3 amplifier. Note stylistic similarity with *Ongaku* circuit (overleaf).



In this way, I made up the 211S amplifier and named this amplifier "ONGAKU"...

Hiroyasu Kondo, Audio Note, Inc.

I LOVE THE 211

The 211 creates a formidable impression because of its shape. But the 211 may appear old-fashioned and unsophisticated to high-brow maniacs for audio equipment. Perhaps this is the reason why there are only a few amplifiers that employ the 211 tube today.

This type of amplifier is a challenge from the viewpoint of the manufacturer. The power supply circuit cannot be normally designed, since the supply voltage required for the 211 tube must be approximately 1000V. In manufacturing the amplifier, we must pay utmost attention to moisture-proofing the chassis and proper insulation of the wiring so as to prevent hands from getting electric shock if one reaches into the amplifier.

However, it is only large triodes like the 211 that provide the best performance that vacuum tubes can offer. The Eg-Ip characteristic of the 211 and its brothers is more linear than most other power tubes. Larger diameter wire is used for the heater, the grid to heater spacing is considerable, and coarse "pitch" is used for the grid winding geometry. This type of vacuum tube is very sturdy and promises a high vacuum integrity, since it was originally intended for demanding commercial and military applications.

When high plate voltage is employed and the pitch of the grid is made more coarse, the amount of "stray electrons" around the heater is greatly decreased, thereby allowing the vacuum tube to work in a more closely ideal manner. In particular, the large triode vacuum tube functions more perfectly when dealing with low level signals, allowing the tone quality to be clear and distinct. If the design of the driver stage is satisfactory, the single triode power amplifier possesses an unbelievably low distortion characteristic, even in the absence of negative feedback. This fact demonstrates the excellent performance of this family of vacuum tubes.

SIMPLE IS THE BEST

What does "good sound" mean? There may be a variety of interpretations. However, a good sound must mean a "natural sound". The meaning of "natural sound" depends on the interpretation of the word. There may be differing opinions -such as "natural" means a sound "without mechanical sound" or that it means a sound "alike to live sound". All listeners would agree that natural sound must not include mechanical sound. A mechanical sound will paralyze the listener's senses when listening to the music for an extended period of time. There are many factors which can produce mechanical sound.

It is an interesting discovery that when mechanical sounds are thoroughly eliminated, we *can* reproduce live sound. What must we do to eliminate mechanical sound? First, we must simplify the audio circuitry. Next, we must carefully select the components which are used in the equipment.

At the closing stage of the vacuum tube amplifier age, tube circuit technology was in a highly advanced state. It was like the advanced evolution of dinosaurs at the close of the dinosaurian age. When I was only 20 years old, I concentrated my energies on the study of "negative feedback theory". At such an inexperienced age, one tends to concentrate on a meeting point, where theory seems to meet reality, instead of focusing on the sound itself. I still remember that I was trying to make up an ideal circuit so as to produce a good sound and my soldering iron was always in its heated state. In spite of my efforts, I could not go beyond the wall of "good" sounds. I finally arrived at the conclusion, after considerable trial and error, that the most important thing is to "make up an amplifier without depending on negative feedback." In fact, I found that I had to strive to simplify the circuitry even without negative feedback and also to develop my understanding of the characteristics of materials to be used and their effect on sound quality.

At one Audio Fair last year, we compared sound reproduced by a transistor amplifier produced by a famous manufacturer and sound reproduced by a 211 vacuum tube amplifier of apparent good quality. To my surprise, the 211 amplifier sounded exactly like the transistor amplifier! I expected more from the triode. Perhaps this was due to the use of feedback in the triode amplifier. Clearly to raise the performance of a single triode amplifier above the crowd it is necessary to optimize the design and parts quality used in its realization. It is not enough simply to use triodes.

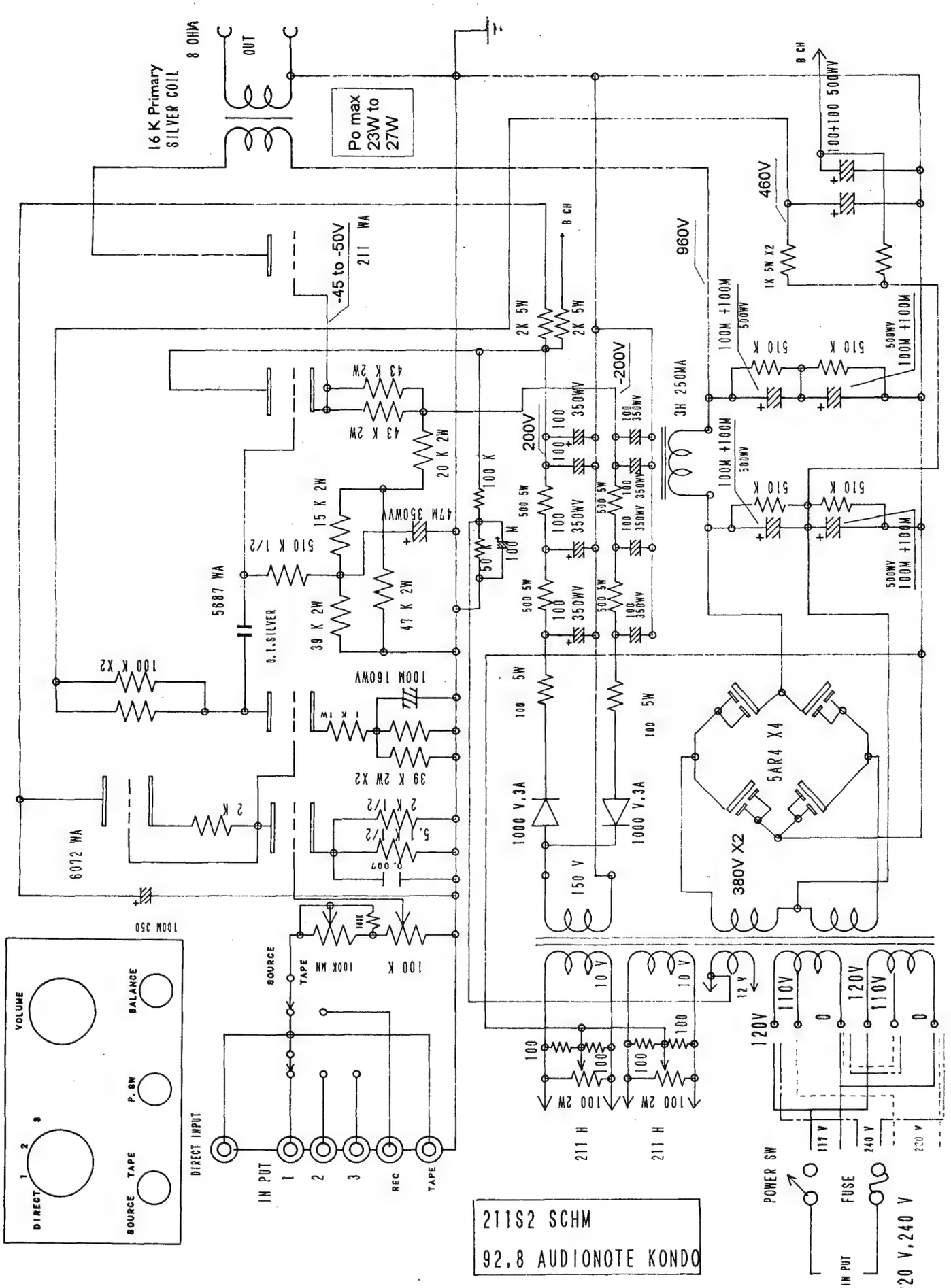
I reemphasize that it is necessary to simplify the fabrication of an amplifier and to carefully select highest quality parts in order to reproduce a "quality of live sound" free from mechanical sound. These are the most important considerations in producing an ideal amplifier.

I AM AN ENTHUSIAST FOR SINGLE ENDED AMPLIFIERS

The single type power amplifier enables greater simplicity compared with other types of amplifiers, if high power is not a requirement. Even a non-feedback single ended amp can provide low distortion with proper selection of power tubes. With the right parts, the sonic results can be excellent and we can enjoy a more dynamic sound than that produced by a higher powered amplifier. If the circuit is simplified, in other words, if the number of parts to be used is reduced even by one, the sound produced by that part, mechanical sound, will be eliminated.

It is interesting that we cannot simply say "the single type can reproduce a good sound." Some single type amplifiers can produce more distortion. Choice of tube types is important in this respect. Distortion in the power tube cannot be eliminated completely, even if the previous stage is designed for minimum distortion. Push-pull circuits can eliminate the second harmonic produced in the output stage. This is the reason why many high class amplifiers employ the P-P configuration.

However, some say that a push-pull output stage makes the sound unclear. There is certainly a potential for unclear sound in these designs due to imbalances. The current state of parts, especially the OPT, is not sufficiently advanced to avoid this problem. The deterioration of sound quality due to improper balance is a challenge for the designer to solve 30 years from now. On this basis, the single type can be recommended, since this type is free from unclear sound due to imbalance.

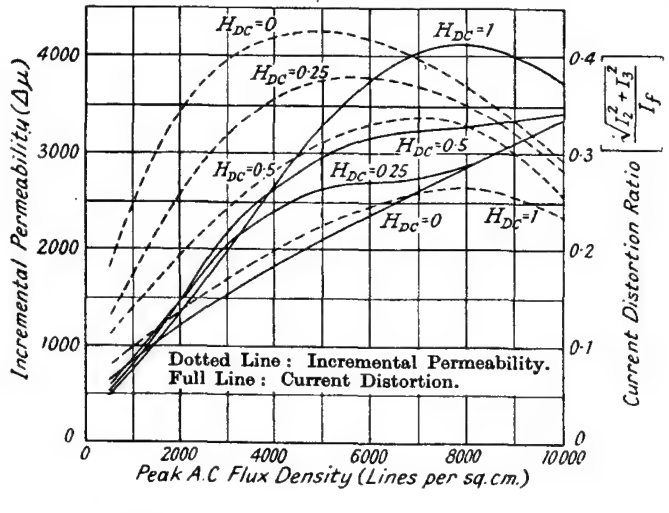

16 K Primary
SILVER COIL
8 OHM
OUT
Po max
23W to
27W
-45 to -50V
211 WA
B CH
2K 5W
2K 5W
960V
460V
1K 5W X2
100+100 500WV
100M +100M
500WV
510 K
-200V
3H 250MA
200V
100 350WV
43 K 2W
43 K 2W
20 K 2W
100 K
15 K 2W
47M 350WV
510 K 1/2
5687 WA
0.1 SILVER
39 K 2W
47 K 2W
50 K
100 M
500 5W
100 K X2
100M 160WV
1 K 1W
39 K 2W X2
2 K
2 K 1/2
5.1 K 1/2
0.007
6072 WA
100M 350
100 K
100K MN
SOURCE
TAPE
VOLUME
BALANCE
P.SW
DIRECT
SOURCE
TAPE
DIRECT INPUT
IN PUT
1
2
3
REC
TAPE
1000 V.3A
100 5W
150 V
380V X2
5AR4 X4
10 V
12 V
100 2W
211 H
120V
110V
0
POWER SW
FUSE
AC IN PUT
117 V
240 V
220 V
120 V,220 V,240 V
211S2 SCHM
92.8 AUDIONOTE KONDO

However, there is a specific challenge which the single type must overcome and we cannot say that the single type is good unless it successfully overcomes this problem. In short, we cannot blindly become enthusiasts for single ended amplifiers.

PROBLEM WITH OUTPUT TRANSFORMER

Through the single type OPT, much direct current passes. If an iron core is fixed to the coil and DC passed through the coil, the iron core will be magnetized as a result, thereby causing deterioration of the characteristics of the low end of the sound range. Magnetization may lead to low-pitched sounds not being produced at all. In order to avoid the hazardous magnetization of the core by DC, an air gap is provided in the magnetic path of the iron core. In order to enhance bass reproduction, the volume of the iron core must be increased so as to increase the magnetic flux handling capability of the transformer.

The world is as kind as it is cruel. The loss generated by the air gap brings the magnetic characteristics to a crisis (Note the hysteresis curve), thereby causing the smooth curve to be changed into a curve which is partially linear and gradually less and less linear as it approaches saturation. Actually, this action enhances the linearity of the mu (permeability) in the small signal region. The enhanced linearity in the low level signal range improves the transmission capability of small signals, thereby enabling greater clarity and detail in musical reproduction. This phenomenon does not occur in push-pull transformers.



Incremental Permeability and Current Distortion Curves Against Peak A.C. Flux Density for Normal Stalloy Core.

Editor's note: This graph illustrates the effect of DC magnetization force (H) on the linearity of incremental permeability in single ended output transformers. From Sturley, K.R. Radio Receiver Design: Part. 2, 3rd printing, Wiley, 1949. Abstracted from Partridge, N. Harmonic Distortion in Audio Transformers, Wireless Engineer. Sep., Oct., Nov. 1942 (Thanks to Dr. Tom Hodgson for this citation).

Merely increasing the volume of the iron core, i.e. increasing the size of the sectional area of the iron core, will not necessarily lead to improvements in musical reproduction. There remains the problem of the tone quality reproduced by the material of the iron core. This is the reason why our company manufactures the OPTs at our own plant. Needless to say, we carefully select the material to be used for the iron core (by placing an importance on the resolution of sound) so as to reproduce good tone quality. Our transformer employs a cut core. A non-magnetizing band is used for the core as well as a non-magnetic transformer case. We pot our transformers with 24 hours-curing type epoxy to fix the coil and core securely to avoid mechanical resonances. The wire is wound around the bobbin by hand so as to provide a proper tension in the wire. No other OPT in the world is manufactured with such attention to the resulting quality of tone.

MATCHING OF OPT AND POWER TUBE

The capability of an OPT is typically indicated in terms of low end performance, for instance, wattage that can be transmitted at 50 Hz with 3% distortion. The type of distortion introduced in the OPT is distortion of the AC signal current, a most troubling type of distortion. The level of distortion produced in the output stage varies with the relation of the plate resistance of the power tube to the load impedance reflected to the primary of the transformer. The OPT for the Ongaku provides excellent performance through the entire audio range, because the primary impedance is a very high (20K ohm) and first class silver wire is used. The size of this OPT is large beyond common sense.

This single triode amplifier displays outstanding low end characteristics when compared with other amplifiers of this type because the OPT core volume is very large. It can successfully reproduce a very soft and warm low-pitched sound. We tend to imagine that we can enhance the tone quality if we were to utilize high permeability core material. But permalloy has a weak point in that it cannot provide enough power in low notes, since it will saturate at a magnetic flux density below the operating point of power amplifiers. In order to reproduce good quality sound, we must carefully select the iron core material, carefully specify the winding method, and choose the material of the transformer wire with optimal sonic results in mind.

CONDENSERS

A coupling condenser is often necessary in vacuum tube amplifier circuits. The measurement of the internal series resistance of the condenser often shows an unexpectedly high value. This is not an exceptional case in a small capacity condenser. The cause of this problem is in the structure of the condenser.

The largest problem with the tone quality of the condenser is a "noise between electrodes" - audible energy created by the above-mentioned resistance. Once this noise is produced, the electrode-to-electrode area will produce noise continuously. It adversely affects the tone quality because of its high Q resonance. The reproduced sound will become a metallic sound or a frivolous sound just like a rubbing sound produced by high-polymer films. The problem is part electrical and part mechanical.

The problem with condensers is not limited to crude forms of distortion. We are manufacturing condensers with particular emphasis on materials in order to minimize sonic deterioration. Specifically we use a thick silver-leaf for the electrode and wind the foil by hand making sure to provide enough tension. I still remember my deep emotion when I first listened to an amplifier using the silver-leaf condenser. The tone quality of this vacuum tube amplifier is so excellent that it is unparalleled in the world. The reproduced sound is, needless to say, free from metallic sound. A very dynamic sound

effect and sound approaching live sound can be reproduced. The pizzicato of low strings can be reproduced properly in time. The reproduced sound really offers "music." Although the higher cost of the silver-leaf condenser is a disadvantage, the use of this type condenser is inevitable when the goal is to reproduce a really good sound. This must be a "favorite amusement of a king."

CIRCUIT OF ONGAKU AMPLIFIER

The circuit itself is unexceptional. The 211 is driven by SRPP input stage, a common type voltage amplifier comprises the second stage and a cathode follower provides the third stage. The first stage is DC coupled to the second stage, as are the driver tube and output stages. A high supply voltage around 500V is applied to the second stage so as to ensure enough driving voltage for the 211 grid. On the third stage, the minus power supply supplies the voltage to the cathode so as to regulate bias voltage. An important feature of this circuit is its power supply circuit. A full wave bridge is constructed from four 5AR4 tubes with sections paralled to rectify the B+ supply. We use the utmost care when selecting the vacuum tube, since the performance of the vacuum tube determines the quality of sound to be reproduced.

SILVER WIRE WOUND OUTPUT TRANSFORMER

The most significant mistake of theoretical audio maniacs in this century is that they threw away the OPT. In many cases, transformers can adversely affect the quality of reproduced sound but I feel it is not correct to employ the OTL without conducting adequate experimentation and without particular attention to design considerations.

Although they say that the resolution may be degraded if a signal is transmitted through the OPT, it is a well-known fact that the transformer can offer a good feeling of the music that the OTL cannot. Accordingly, we are required to solve the problem of how to enhance the resolution of sound with OPT.

I can still remember my deep emotion when I reproduced the sound using the MC step-up transformer wound with silver wire 13 years ago. Using silver, I could successfully resolve the "problem with the noise produced by the transformer," which we could not solve up to that time in the recording studio. From that time, we began using silver wire in a wider range of applications. We finally arrived at the conclusion that magnetism matches the silver wire better than the copper wire. The performance of the silver wire used in the magnetic circuit is wonderful. The performance gives us a feeling as if a signal which once got blocked rushes forward like floodwater. We can perceive that the signal flows smoothly without binding. The work of the silver wire is especially wonderful in the small signal area. The silver wire wound transformer contributes to the enhancement of tone quality reproduced by the vacuum tube amplifier, thereby allowing the vacuum tube amplifier to become famous for its good quality of reproduced sound. In some of our amplifiers, such as the KEGON/C, copper wire is used for the primary side of the OPT to reduce cost and only the secondary is wound with silver wire.

OTHERS

The chassis of the Ongaku amplifier is made of pure copper for the purpose of enhancing the tone quality. The twin-monaural configuration is employed for the purpose of minimizing the interference between the sounds reproduced from the left side and the right side. The realization of such purposes resulted in a larger and heavier chassis. One of the reasons why the "Ongaku" amplifier won world wide fame is the elaborate execution of this amplifier.

EPILOGUE

As a result of our endeavor, the completed 211 can really reproduce "musical" sounds. It is an optimal amplifier for listening to classical music. It not only reproduces a live sound but it also allows the listeners to identify what part of the music is reproduced from what position of the equipment. For instance, when we reproduce a violin concerto, the melody played by the violin is reproduced more prominently than other sounds. In addition, the reproduced music is free from any metallic sound. We can listen to the bright vocal as if enjoying a live concert. I never saw such a highly sophisticated power amplifier before. The 211 "Ongaku" amplifier informs the listener with new life. How can we express such an excellent and majestic sound as this reproduced sound? We can only say "Ongaku!" to describe such reproduced sounds.

We must confess that it is not an easy task to master the secrets of the audio equipment!

ONGAKU FOR THE REST OF US

I don't know about you, but I sure can do without that "mechanical sound" characteristic of complicated designs. Unfortunately, an authentic Audio Note *Ongaku* is not in this year's budget. Actually, the retail price of this amp may exceed my total net worth by a slight margin - even exclusive of shipping charges. If I sell my present system, I might be able to swing a pair of those hand-rolled silver coupling caps though.

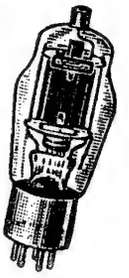
But wait . . . because Kondo-san was gracious enough to share his design with the international experimenter community, we can build our own 211SE amps based on the Kondo masterpiece. Of course, we can't build a real *Ongaku* -- part of the celebrated sonic magic of the amp is in its exquisite material execution and the special virtues of in-house Audio Note parts. But I'll bet the Kondo circuit will turn in a respectable performance even when more pedestrian materials are employed. Until the *Sound Practices* publishing empire hits the "big time", I'm afraid I must settle for second best when a savings of $60,000 is involved.

Some interesting components are available from Audio Note, UK which would be appropriate for a "Poor Man's Ongaku" project, including single ended transformers for the 211 and a line of oil/paper coupling caps. A primary mission of the Audio Note UK operation is to make some of the findings of Kondo's uncompromising explorations available to the audiophile who isn't blessed with an Ongaku-sized budget. Toward this goal, they are developing a line of lesser-priced equipment of high musical achievement along with providing a selection of music-quality parts for fellow audio adventurers.

OK, homebrewers. . . time to get those soldering irons "in the heated state", as Kondo-san puts it. Next time: my report on "Building the Poor Man's Ongaku" and more on this interesting design.

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A SINGLE "807" AMPLIFIER



A CURE FOR TRIODE FEVER??

by Gordon Rankin, Wavelength Audio

I would like to start by mentioning an idea that has proven to be a valuable tool these past several months: Design without preconceived understandings. Why?? Well, I have been designing audio equipment for over 15 years and have listened to everybody hype their slice of pie and put down their failures. I include myself here. Lately, I have approached some "experimental" designs without preconceived biases and they have performed wonderfully.

The reason that designers have preferences in the first place is that there are things that they have tried and have had success with, and things that they haven't tried at all. Often, this or that topology or approach gets a bad name by word of mouth for no good reason. The reputation of a design assumes a life of its own apart from its actual performance. Some technologies come to bear a name, positive or negative, that is not fully deserved. Also *nobody* has tried *everything* and we have to think of reasons for sidestepping those approaches we haven't explored for one reason or another.

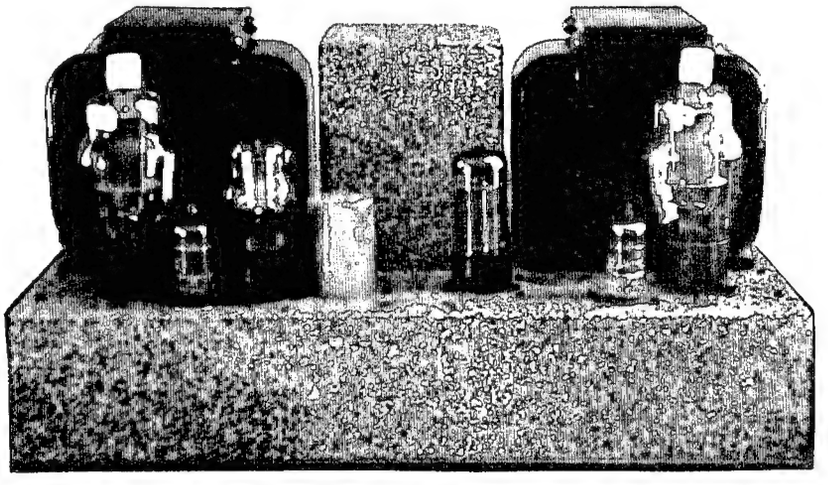
In thinking about single-ended amp designs, I wondered, "why not a PENTODE based single ended amp?" Several of my push pull pentode amps worked out great after all. In these days of TRIODE FEVER, is our loyal servant the pentode getting a bad name? Anyway, I began to wonder what a nice beefy single ended pentode amp might sound like. Nobody I know had ever heard one . . .the rest, as they say, is history.

The advantages of the pentode tube are simple. The input sensitivity and efficiency of a pentode makes it easy to design a workable simple two-stage circuit. Because drive requirements for the multigrid tubes are moderate, you could use a basic great sounding low-gain triode front end stage. And the output power would be slightly higher than your typical 300B class single triode amp without resorting to transmitting triodes and all the high voltage that involves. There is no reason you can't use, for example, two 6550s in parallel to get a respectable 30 watt power output from a single ended amplifier.

True, pentodes lack the low plate impedance of triodes but we're still talking pure Class A operation. As for the harmonic advantages of the triode, regardless of whether a single ended amp uses pentodes or triodes the second order cancellation of push pull does not occur. Could it be that the magic of single ended triode amps has more to do with the fact that they are single ended than that they are triode based? Maybe a little even-order harmonic helps out with the single pentode configuration?

When you set out to design anything, you have to declare several assumptions so that the remaining variables can be determined. For starters, I decided that I wanted at least ten watts output. This is an arbitrary figure, but I figured my ProAcs would probably like to see at least ten watts on the other end of the wire. This target was well within the capabilities of a single pentode power tube. This modest power target would help keep it simple and I would get to hear what a straightforward, high quality single pentode amp sounds like. Since it was "just an experiment," I decided to do a stereo amp with a common power supply for the sake of simplicity and to cut my losses in case of a loser.

The move away from the popular medium power output triodes - like the 300B - has powerful advantages in terms of tube availability and economy. I chose a mildly obscure (from the vantage point of high-end audio) but highly available tube, the 807. There seem to be an awful lot of 807s on the market relative to the number of products that use them. The 807 was the first and final choice for this design and it proved to be a fine selection. This tube is listed in the tube manual as a beam power tube of the tetrode variety but it is usually illustrated with the suppressor grid tied to the cathode. This is typical of pentodes so let's just call it a PENTODE and get to work.



The 70 pound / 10 Watt Wavelength Audio 807 SE Amplifier

In working with pentode amplifiers, it has become apparent to me that *some* feedback is required - whether global or local to the output section. In a single ended amp with an output transformer only 1 dB down at 30 Hz, I feel that *global* feedback would be a travesty. I was counting on (pressuring) MagneQuest to come up with an awesome design so skimpy primary inductance was not an issue. I guess if the primary inductance were on the low side, one *might* be tempted to use some global feedback to extend the bandwidth on the low end.

I planned to use a few dBs of *local* feedback through a partially unbiased cathode resistor to maintain stability. I have determined that a reasonable amount of local feedback can make an appreciable improvement in the stability and sonics of a nice pentode amp. Local feedback is created by the current going through an unbypassed or partially unbypassed cathode resistor. As stated in the *Radiotron Handbook* (p.327), "If the signal current through the [tube] and Rl (load resistor) is called i_p, then the signal voltage drop across R_k is R_k x I_p, which is proportional to the signal load; hence, current feedback." By limiting the gain per section in this fashion, the linearity is improved and the distortion can be reduced without the time domain problems of global negative feedback.

I called Mike LaFevre at MagneQuest to inquire about a custom transformer for this project. After looking at some curves and spending some time with the *RCA Tube Manual* and the *Radiotron Designer's Handbook*, we determined that the primary impedance of the output transformer should be 6000 ohms. This step is easy thanks to a very useful MAGIC equation for determining the primary impedance required for an output transformer. It can be found on page 561 of the *Radiotron Handbook:*

$$Z_{primary} = 0.9(B+ / Ip)$$
where Ip = Plate current

I tried to verify this equation and, sure enough, the MAGIC number falls between 0.75 and 0.9 in every case I examined.

For a single 807, the trans would have to handle 50 to 60 ma of unbalanced DC. Yes, it would be BIG. There is a lot of wire on that 6K primary - 3028.3 *feet* of #28 to be exact. Mike chose to design it on the same core he uses for the *120 watt* Dynaco A-450 transformer - a hefty 2 1/2", 12.5 pound stack of M6 laminations. A monster.

The primary inductance would work out to be about 64 Henries giving a -1 dB @ 30hz. rolloff. Primary DCR would be 188 ohms about 70% of the resistance which would cause 1 dB of insertion loss (i.e. 300 ohms). A special winding technique would be employed in which a constant secondary resistance is reflected to the primary regardless of which secondary taps are chosen. The transformer would run at a conservative total flux density around 13.5 kilogauss.

When the prototypes came they weighed in at 20 pounds each! The cost of producing an appropriate output coil for such a design is one good reason you don't see too many single ended 807 amps in *Stereo Review.* In fact, a quality trans for this application is bigger and more expensive to create than an equivalent quality unit for a single 300B amp. Because of the higher primary impedance and somewhat higher DC and AC current, *double* the primary inductance of a good single 3K transformer like the MagneQuest FS030 is required for the same LF cutoff. So, if you go the single pentode route instead of the triode route, you'll be saving $$$ on tubes but a chunk of that gets reinvested in iron.

When I set out to design this amp I knew it wouldn't be Wavelength Audio's first major international marketplace success. Single pentode amps are a bit marginal, they're still a few years away from a category of their own in the *Audio Annual Equipment Directory.* It was just an experiment but it is one that really worked well. Surprisingly well. If you're in the market for a 60 pound 10 watt stereo single pentode amp project, I present to you the Wavelength Audio single 807 amplifier. Go ahead and build one today. ENJOY!

DESIGN PROCEDURE

For the benefit of those who are perhaps curious what goes into the design of an amplifier, let me go through the procedure I used to design this amp on a step-by-step basis. Don't be intimidated by the equations; you probably got way beyond this level in high school algebra. If you're a pure novice at electronics, but anxious to learn, read through the boring stuff a few times and some useful concepts will stick. Skim over the details but try to get the big picture.

For those of you for whom the process of designing an amplifier is old hat, relive it with me. I'm sure you'll recognize the math, minor screw-ups and late night phone calls. This may be a unfamiliar product but the same old basic logic applies.

Here is a general outline of the necessary steps: We know the power output desired, the input voltage (1V), and the nature of the load (8 ohms).

1- Determine total gain needed for the amp
   a) Calculate output voltage required for a given power output in Watts with 1V input sensitivity
   b) Determine output transformer losses
   c) Determine total gain

2- Determine gain distribution among stages starting at the output and working back toward the input. Make adjustments for available components and calculated circuit values.

3 - Set up the final working parameters on a stage by stage basis.

This would be a *very* straightforward exercise for an amp without local feedback. As it is, a few extra steps are required to set up the 807 cathode circuit they way I did it.

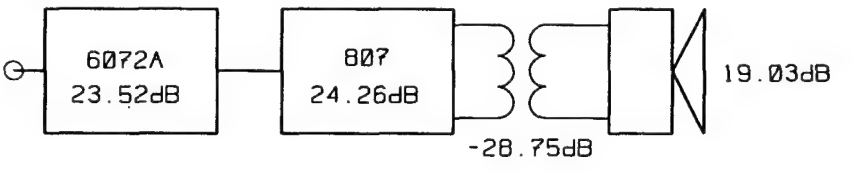


Fig. 1 - Gain block diagram of 807 amplifier

No big deal - anyway, it allows us to squeeze in a lesson on bypassed vs. unbypassed cathode resistors along the way.

THE OUTPUT STAGE

OK, we want a 10 watt amp. The output *voltage* for an 10 watt amplifier considering an 8 ohm load is:

$$Watts_{out} = V^2/R \qquad \text{(eq.1)}$$

This means that:

$$V = \sqrt{R \times Watts_{out}} = \sqrt{10 \times 8}$$

or 8.944 V across 8 ohms

To determine the total gain required, we need to know the loss of gain in the output transformer. There is a loss of voltage gain because our output transformer steps *down* voltage as it steps *up* current. It can be calculated as follows:

$$A = \sqrt{\frac{Z1}{Z2}} = \sqrt{\frac{8}{6000}} = 0.0365 \qquad \text{(eq. 2)}$$

Z1 = output impedance
Z2 = primary impedance
A = voltage gain loss

We will assume the magnetic losses to be negligible for purposes of calculation although there is some loss in practice.

With the above information we can determine to total gain required:

$$V \times \frac{1}{A} = 8.944 \frac{1}{0.0365} = 245 \qquad \text{(eq. 3)}$$

We need a total gain of 245 at the output of the amplifier but we must not utilize the entire capability of the output tube because we want some local feedback. So how do we work out the gain distribution of the amplifier?

From the 807 curves, we can determine that with a screen voltage of 250V and an output impedance of 6K, the gain will fall between 10 and 30. To employ some local feedback and still get sufficient gain, I decided to *partially* bypass the cathode circuit. That way, I could adjust for the desired gain.

807 CATHODE CIRCUIT

The cathode to grid voltage at 450V on the plate and 250V on the screen is about 18V. This means that if the gain of the driver stage exceeds 18, the amp will clip at the input to the 807.

So, let's play it safe and set the input stage gain at 15 and the gain of the 807 just over 16 (15 X 16.33 = 245).

For 10W output from an 807 in Class A, a current of 50 to 60 ma through the tube is required. Therefore, the *total* cathode resistance required for 18V cathode to grid works out to be 360 ohms using Ohm's Law. This determines the DC (bias) aspect of the cathode circuit.

Now let's look at the AC (gain) function of the cathode circuit. We need a gain of 16.33 and we know that our load is 6K and the rp = 38K. By the unbypasssed equation (eq. 6), we can see that we need an unbypassed resistance of 169 ohms. So let's bypass 200 of the 360 ohm total and use a variable resistor for the unbypassed part so we can dial in the bias to exactly 50 ma.

OK, Kids, *here's the math.....*
The gain of a stage with a *fully bypassed* cathode is given by:

$$gain = \frac{u \times Rl}{Rl \times rp} \qquad \text{(eq. 4)}$$

Rl = Load resistance
rp = Internal plate resistance
u = amplification factor or "mu"

The gain of a stage with an *unbypassed* cathode resistor is given by:

$$gain = u/(1+[(rp+Rk \times u)/Rl])$$

Rk = Cathode resistor (eq. 5)

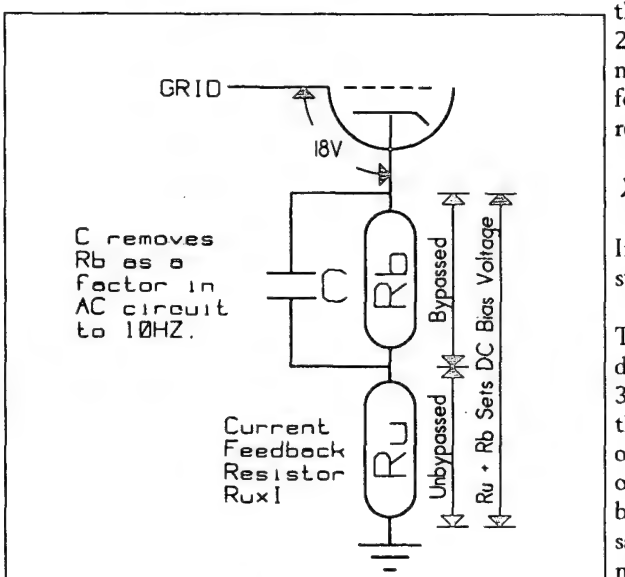


Fig. 2 - Functional 807 cathode circuit diagram

At 450V B+ and current of 50 ma, the transconductance of the 807 is 5850 umhos and the Rp is 38K so the mu works out to about 222.

Rearranging the unbypassed cathode gain equation (eq. 5) we get:

$$Rk = [(u/gain) - 1 \times Rl - rp]/u \qquad \text{(eq. 6)}$$

Next we calculate the bypass cap value. The bypass acts like a dead short to AC down to a particular frequency depending on its capacitance. Below this frequency it will cause a loss of gain. I chose 10 Hz for this single ended amp as the -3 dB point for the bypass cap. 3dB down from 16.33 is a gain of 11.55 at 10 Hz - i.e., 0.707 X 16.33.

Plugging 11.55 into eq. 5, we see that the value of the unbypassed Rk should be 323. Since the unbypassed portion of the cathode resistance required for a gain of 16.33 is 169 ohms, we subtract that figure from 323 to find the reactance we need at 10 Hz.

The total reactance (the capacitors impedance in parallel with the 200 ohm resistor) is 154.4 ohms. We need to calculate what part of this impedance comes from the 200 ohm resistor and which part comes from the capacitor - in other words, what impedance in parallel with 200 ohms will give us 154.4.

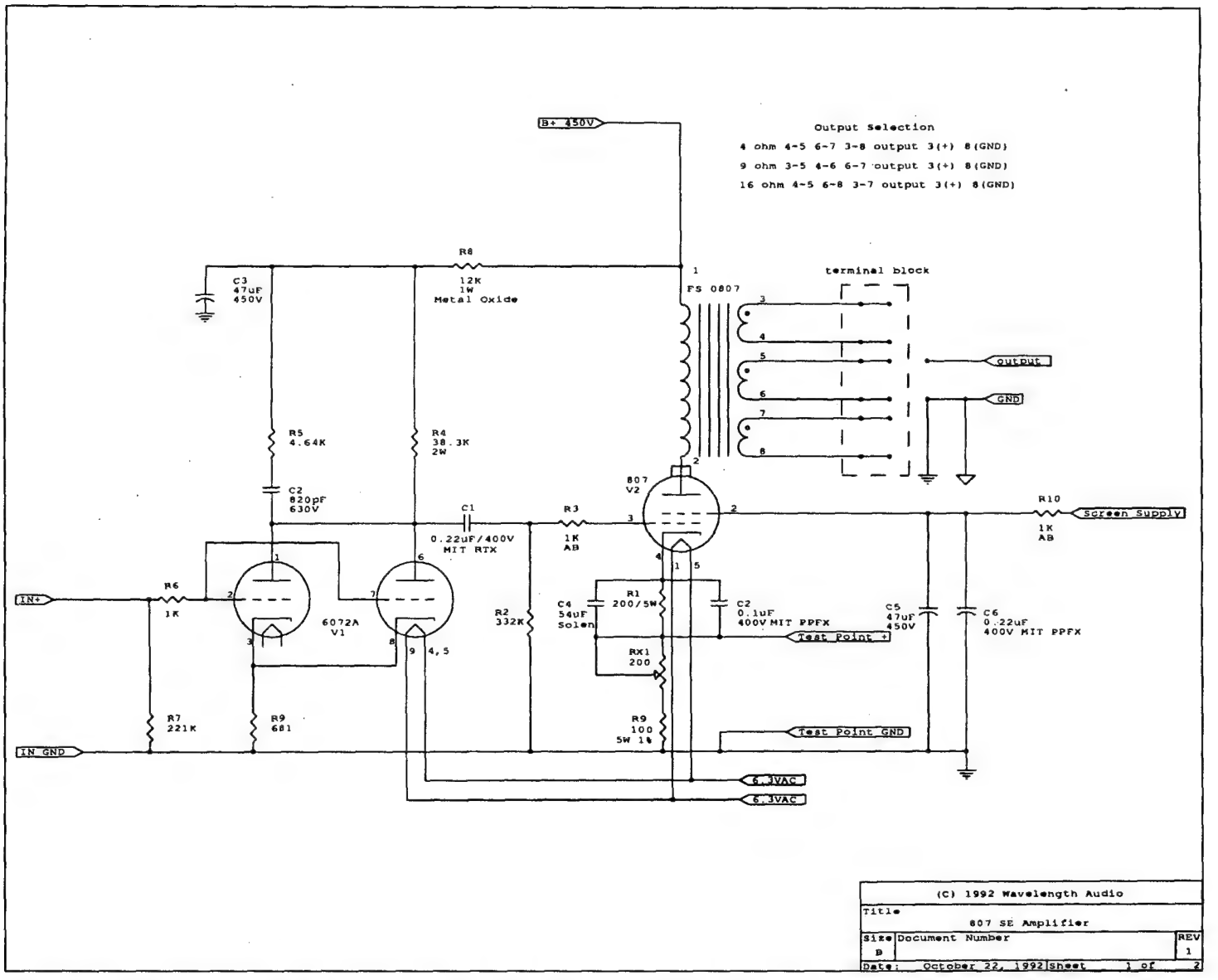
$$\frac{1}{Z} = \frac{1}{R} + \frac{1}{Zc} \qquad \text{(eq. 7)}$$

We end up with Zc = 680. At 10 Hz that requires a capacitance of at least 23.4 mF. We know this from the formula for capacitive reactance. This formula tells us what size cap has a reactance of 680 ohms at 10 hz.

$$Xc = 1/(2\pi fC) \qquad \text{(eq. 8)}$$

In my amp I used 24 mf, the nearest standard value to 23.4 mf.

The output section is now completely designed with a cathode resistor of 300 fixed and 200 variable, 450V on the plate, 250V at the screens, and an output transformer with an impedance of 6K. We have 5.56 dB of local feedback on this stage. The tube manual says that an 807 in self bias can have a maximum grid resistance of 0.5 megohms. I decided to use some 332K HOLCO units I had on hand as the in-



put resistors. It's a good idea to use a value that is at least 20% less than the maximum permissible value. That pretty much completes design of the output section.

THE INPUT STAGE

Now let's take a look at the input section. We need a gain around 15 to 18 with good noise immunity and enough drive to carry the 807 - with a 332K on the 807 grid, that's not a whole lot.

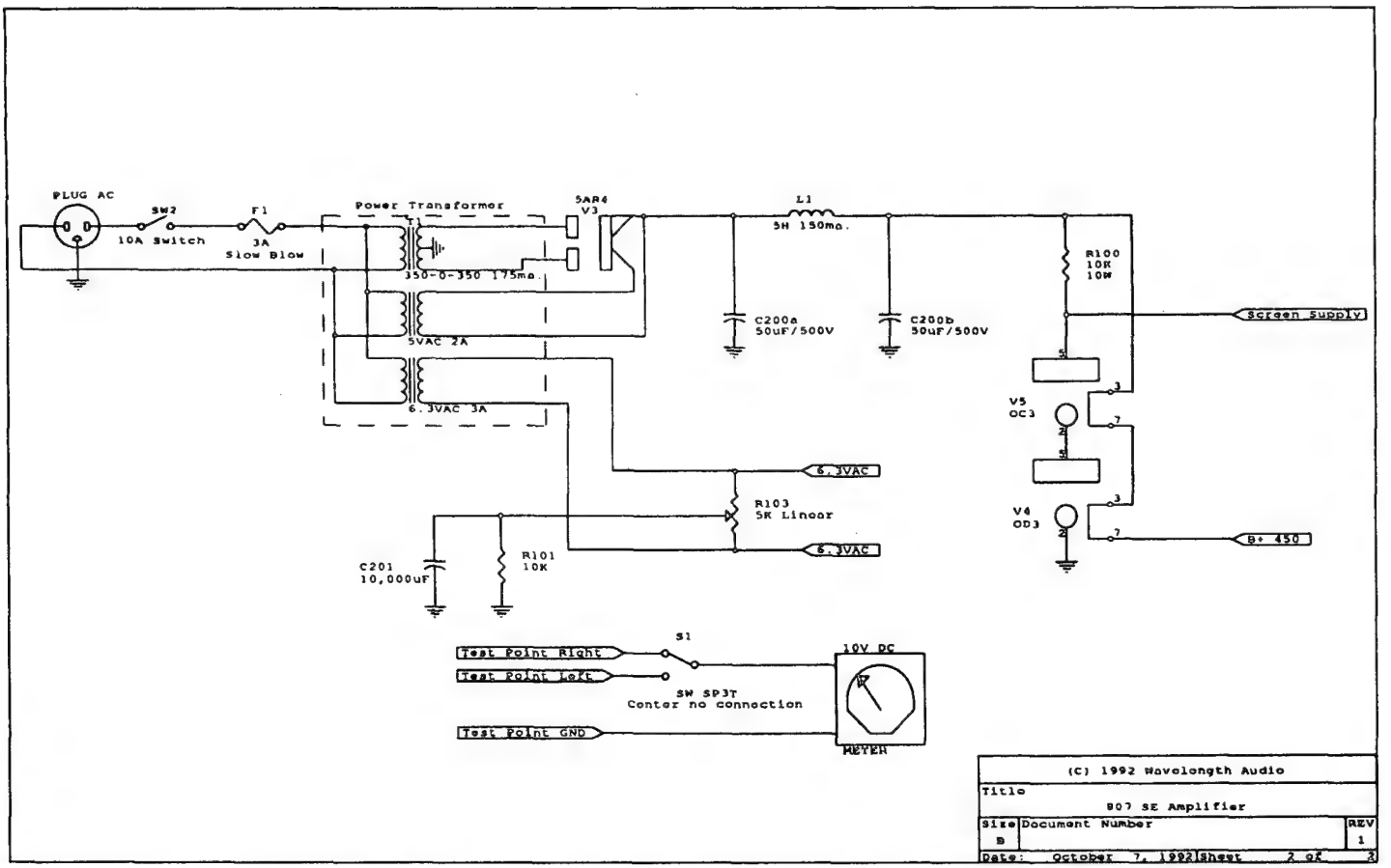
If we look at the dual triodes in the tube manual, we find units with mu of 20, 40, 60, and 100. 20 is too close to the needed stage gain to give any headroom and 100 is much too high to keep the gain below 18 without employing *lots* of feedback to reduce gain.

So we are left with the tubes with mu of 40 or 60. Although some designers love 'em, I haven't had much luck sonically with the 12AT7 family.

Anyway talking with a certain editor, the subject of the *Ongaku* came up. I said to myself, "Hey, what about the 12AY7 series?" The 6072A, the industrial version of the 12AY7, used as the input tube of the *Ongaku* is a particularly attractive specimen and it is readily available from distributors of NOS tubes. It has an average mu of 44 and a max. plate dissipation of 1.65W per section. We will be using the 6072A at 2.5 ma per plate and a plate voltage of 200V. We can parallel the filaments and run the tube on the 6.3 VAC tap of our power transformer.

By using the two halves of the input tube in parallel, we benefit in several ways: the rp is cut in half so the stage gain increases accordingly and noise is cut in half. Both attributes are desirable in the front end of a good amplifier. The 6072A is controlled for low noise and low microphonics so it's a natural for this application.

I set the operating point of the 6072A per the gain required of this stage. We'll run this stage at around a 400V supply so that we can use a readily available 450V decoupling cap (C3). The 6072A is running at 2.5 ma per side or 5 ma total. And we need a cathode to grid voltage of at least 2.5 to 3.5 V to provide some headroom so that we don't clip the input signal. With three volts on the grid and 2.5 ma plate current we are looking for a plate voltage of 200V. At 5 ma for both sections, a 681 ohm I had on hand used as the cathode bias resistor [R9] would give us 3.4V on the grid. Given that this resistor is unbypassed, we get 3.8 dB of local feedback in the input stage.



The load resistor (R4) is determined by the fact that we have a stage voltage of 400 and we want about 200VDC on the plate of the 6072A. I chose a Roederstein MK8 38.3K 2W metal film for this application since 38.3K x 5 ma + 200V = approx. 400V. If we plug this into the handy unbypassed gain equation mentioned above:

$$gain = u/[1 + (rp + u \times Rc)/Rl]$$

The result is a little more than 18.7 (Rl is equal to 38.3K in parallel with the 332K input resistor of the 807 because the coupling cap has negligible reactance at signal frequencies). Well, 18.7 is a little more gain than we would like but there will be other losses in the circuit due to tube and component variations and some loss in the output transformer.

The compensation network (R5 and C2) is useful because the amplifier will overshoot somewhat without it. As far as I know, this type of network was first seen in Williamson type amplifiers. I picked this trick up at Erno Borberly's suggestion. He gave me some basics on it and this is what he told me: set Rx = Rl x 0.12. The value of C is determined by running a 1 KHZ square wave through the amp (terminated with an 8 ohm dummy load) and increasing the value for the best looking wave. An 820 pf worked great with the 4.64K resistor I used. A 1000 pf cap caused the leading and trailing edges of the square wave to round off a bit. A 680 pf cap had a bit of overshoot at both ends of the square wave.

POWER SUPPLY

The power supply is all there is left to design. With the 807 cathode current at 60 ma per channel, the driver tubes running at 5.3 ma each, and a VR (voltage regulator) tube current of 20 ma we're in the ballpark of 150 ma. I chose a power transformer rated at 175 ma. If you wanted to run separate screen supplies, a 200 ma transformer would be a better choice.

We need a B+ of 450V and the 5AR4 drops about 37V. A 350-0-350V transformer will work fine. Actual voltage under load was 461V. By the way, the new Russian-made Sovtek 5AR4 is a promising replacement for the ever more scarce Mullard classic version. The voltage drop is about the same as the original, the warm up is a bit faster, and it sounds pretty good. The latest version of this tube is the first "production series" and quality is better than in some of the prototypes which were circulated earlier.

A little spot on VR tubes is probably in order, since you don't see them too often these days. In fact, I had a little trouble finding some practical information about VR tubes. For instance, I was curious about the purpose of the wire between pins 3 and 7. I thought that maybe the B+ through this wire helps the tube to fire. A call to a man of infinite tube lore, Ned Carlson of Triode Electronics, yielded the correct answer. This feature ensures that the VR tube is running: if the tube is broken, removed, or open the B+ is interrupted to save the circuit. When using VR tubes, make sure that you have a good deal of current running through them to ensure good regulation. In pentode circuits, the screens must have a stable source, otherwise the bass will suffer. The OD3 glows a beautiful luminescent purple when in operation and it makes an excellent conversation piece.

DOWN TO TWEAKING

Enough MATH! Let's get down to the components. I'm a tweaker and will always be. I have spent hours listening to cable, resistors, and caps and I decided I like HOLCOs best overall. I am using AB 1K carbons as grid stoppers and one Roederstein because of the high wattage. The 5 W cathode resistors are all Clarostat 1% low inductance wirewound

types and the trim pot is a 3W multi-turn Spectrol unit. All other resistors are HOLCO half watters (H4s). The film caps are MIT PPFX except for the 820pf which is a MIAL and the large value caps which are Solen FastCaps. I really like the PPFX and the only thing better that I have heard is the RTX at more than twice the cost. Internal wiring was Kimber Kable TCSS 20 ga except for a piece of Cardas Twinax for the input lead.

A short digression on component vendors here. Listen, don't just sit around designing stuff and calling experts like Ned at Triode *every* time you can't figure something out. Get a library and study! If you do need some advice then at least buy something. These people aren't just sitting around waiting to answer questions they are in business and need to pay the bills. Advice from educated vendors shouldn't come cheap. They must study, tinker, and test with the best of them and their insight is usually hard earned indeed. Enough said.

With every project comes a unique problem. Seldom does a new product work out perfectly the first time. With this amp I had an oscillation problem in the right channel. Both channels were exactly the same. I swapped everything, including output transformers. Finally, I shorted the input and it came up fine. The problem was that the shielded input cable ran near some of the output transformer wiring and it was picking up some of the output and looping it back to the input. It was a twinaxial cable with the shield ungrounded - OOPS! Terminating the shield at the input end fixed that one -- not without 10 hours of goofing off though. Live and learn. Let's play music.

OK, WHAT ABOUT THE SOUND?

I was really curious to hear this amp since it was my first single pentode amp. My system is a Wavelength Audio Control Panel preamp fed by a heavily modified Phillips 680 CD player using a Sony DTC-700 DAT as a D/A. Phono stage is a LINN Basik with the Basik Plus arm and the K5 cartridge to a homebrew pre-preamp. Speakers are the fabled ProAc Response Twos. In short, this is a modern high-end type system. Not a pair of *Klipschhorns* or something.

My first listening was done on a pair of Wharfdale Diamond IIIs I use in the lab. Hmm, sounds pretty powerful but the lab is small. Power out measured 8.9W out before clipping. I tweaked the compensation network and took the amp out to my main system to fire it up for serious listening.

Wow, this amp can really play loud! The highs were super clean and it was the quietest tube amp I ever built. The bass was real tight but lacking in the last bit of punch in the low end. Putting in on a scope, I found a -3dB point of 40 Hz at the low end and it was good out to 50 KHZ. There was a phase shift of about 25 degrees at the low end. Not bad but I thought I could get the low end response down a bit more.

I increased the value of the screen bypass cap and that brought the power up to 10.2 watts. After some measurements, I realized that the variable resistor was set to 10 ohms not 69 as calculated. Therefore, I needed a cap of *over 50 mf* to bypass down to 10 Hz. I put a 30 mf cap in parallel with the existing 24 mf unit and that brought the -3 dB point down to 22.6 Hz. That's more like it. Still had 25 degrees phase shift at the low end.

I was amazed at the subjective performance of the amp. My ProAcs are only rated 86 dB @ 1 watt sensitivity and the manufacturer recommends a *minimum* of 100 watts. But this 10 watter can really crank! The amp had excellent bass definition and extension, with my speakers at least. Maybe separate screen supplies would *really* spice up the bass region. One could argue that screen regulation is much more important than plate regulation and VR tubes are certainly *not* the last word in regulation. But I can't argue with the sound I got with the setup I used.

I was actually surprised that the amp worked so well with my regular system. I thought I might have to get a pair of more efficient speakers to audition the amp. A pentode amp with no feedback will have a relatively high output impedance so it is rather sensitive to the choice of speaker. The measured output impedance was 1.16 ohms @ 10KHZ. By comparison, my modified Dyna ST-70 measures 0.105 ohms Z_{out} @ 10 KHZ. A stock ST-70 would be even lower since it runs more global feedback. It surely didn't hurt that my ProAcs are a pretty solid 8 ohm load, dropping only down to 6.4 ohms at 300 Hz. I honestly thought that the 807 SE was the best driver I heard for this speaker.

I'm not much good at describing my listening experiences in flowery prose so I headed down to the local high end store, Audible Elegance, for fieldwork. We hooked the 807 SE up to a pair of Thiel 1.2s, 86dB efficient two ways. The listening team thought the unit sounded especially clean without any of the hum, noise, or excesses of vintage tube gear. However the low end was seriously lacking. I would attribute this to the fact that the output transformer was strapped for 8 ohms and the Thiels are 4 ohm speakers which may drop well below the nominal impedance.

Rather than rewiring the amp, we switched over to a pair of LINN Nexus II which are rated at 8 ohms. The amp was much happier and so were our ears. No heart stopping bass but it did provide full robust low end performance. Jeff, the resident tube expert, was quite surprised that a single ended unit succeeded so well in a full range capacity. We speculated that maybe bi-amping with a push-pull amp on the lows would really open up the sound. The midrange and highs were very engaging. A few remarked that it was the most 'tubey-sounding' amp they had heard recently and it was meant in a complimentary way. Someone commented that modern tube amps had lost much of the musicality which was once the special thrill of the vacuum tube amp. The dimensional presentation of the amp was excellent indeed with superb '20 foot past the back wall' resolution of depth.

In short, the overall consensus down at the store was that the amp was quite an impressive performer *with the right speaker* and that it might be a real giant killer in a bi-amp system with a push-pull amp handling frequencies below 100 Hz. My experience with the Thiels seemed to confirm the obvious rule that it is a good idea to ensure that the output transformer is configured for a good match with your speaker.

I would say that the 807 SE amp was a successful experiment. The sonic results far exceeded my expectations. As a designer, the 807 SE provided one more good argument for keeping an open mind and exploring new directions. As an audiophile, the 807 SE is giving me some really nice sounds from a product I wouldn't have taken seriously only a short time ago.

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Langford-Smith, F., *Radiotron Designer's Handbook - Fourth Edition*, 1953.

RCA Tube Manuals - various editions.

POINT TO POINT TEFLON CIRCUIT BOARDS

by Mike VansEvers
Clarus Recording Products

A step-by-step procedure for easy to make, premiere quality circuit boards with all of the advantages of point-to-point wiring and none of the drawbacks of ordinary etched copper boards.

Teflon is a great material for making homebrew circuit boards. It is very soft, so it is easy to work with and using the method outlined below, no nasty chemicals are required. But the best reason for teflon boards is the same reason that teflon film caps are arguably the best audio capacitors (see refs 1-4). Teflon has an extremely low dielectric absorption factor. What this means is that teflon caps smear audio signals less than any other type of cap. By now you're probably asking yourself: "What does this have to do with circuit boards?" Quite a lot actually.

A typical copper clad circuit board acts like distributed-network small-value capacitors between all metallic current carrying objects located on it. The definition of a capacitor is two conductors separated by an insulator. Two forks separated by a napkin is technically a capacitor and can be used as one, although not easily and no claims are made for the sonic merits of this design (some prefer spoons...). Because of the high impedances found in vacuum tube circuits, even small value capacitances are significant. Subjectively, the same circuit on teflon (vs. fiberglass, phenolic, etc.) will pass more low level information, enabling you to "see" further into the sound stage.

I first heard about the use of teflon as circuit board material in a pizza parlor in the late Eighties. Not just *any* pizza parlor but the home of the BEST pizza in this spiral arm of the galaxy, Cesare's New York Pizzaria in Tampa, FL. And my guru was not just any hungry audiophile but John Beaty who, along with Mike Moffat, ran THETA - one of the leading tube equipment manufacturers of the late Seventies. Since that memorable meal, I learned that David Berning also champions the use of teflon boards. Spectral's preamps, Theta Generation 3, and John Curl's Vendetta use teflon boards. A growing number of companies, including Mark Levinson, offer teflon boards as a rather expensive option in some of their products.

I have built two sets of monoblock tube amps, a tube stereo power amp, and two pro/audiophile tube microphone preamps on teflon boards. Some traits these products all share is excellent detail and openness.

When a friend rebuilt his trusty Vorhis Last PAS preamp onto teflon, he didn't talk about anything else for at least two weeks. The rest of us quickly became sick of listening to him brag about his damned phono stage. Listening to it was another matter entirely. The sound stage had become much wider and deeper and instruments had more definition and "air" around them. It was truly a major step forward. . .but please don't tell him that I said that because I'm sure I have to hear about it all over again.

Eggs, water, dirt, magic markers, you name it, it won't stick to teflon. Most glues don't either. Therein lies the rub: attaching copper to teflon isn't easy or cheap. Fiberglass is MUCH easier to attach copper material to and much more economical. Fortunately, we don't want a conventional etched copper circuit board. For tube circuits, point-to-point wiring is much better: layout is often simpler and the above-mentioned distributed capacity problems are lessened. Our alternative method will be a *point-to-point circuit board* built on teflon, the best of all possible worlds. No noxious etching chemicals are required and the questionable audio quality of etched conductors is avoided.

As an electronic material, teflon has many advantages but it does have some mechanical shortcomings. Teflon is not very rigid - almost frozen cream cheese comes to mind. Where 1/16" fiberglass works you will need 1/4" of teflon. You can get away with thinner teflon stock for totally passive or solid state circuits. But installing and removing tubes from their sockets applies a lot of shear force and could easily tear up a thin (< 1/4") teflon board. The right teflon for tube circuits gets pretty expensive because it is sold by weight. Tampa Rubber and Gasket sells 1/8" teflon for about $20 per square foot. Quarter-inch teflon sells for four times as much, or approximately $80 per square foot. The smallest piece of teflon Tampa Rubber and Gasket likes to sell is 4" X 4" but suppliers will often have smaller leftover pieces which they will sell at a better price. A square foot will make quite a few preamp or power amp circuit boards and the improvement in spaciousness and "air" is certainly worth it. And you will save a few bucks and a small piece of the environment because etching supplies aren't needed.

As an alternative to making the whole board of teflon you can use insulated standoffs using teflon. However, in high impedance tube circuits proximity to the chassis can create adverse effects. Small capacitances to ground in lots of places can add up to a big high frequency rolloff. The best strategy to prevent excess capacity to ground is to mount the board over a cutout slightly smaller than the board.

Here are the steps I follow for making my own teflon circuit boards:

1) Make an initial estimate of the size your circuit board should be. Determine where standoffs or other mounting hardware will be placed. Some layout considerations to keep in mind:

a) Keep input wires/components at least 1-2" away from output wires/components. If you can't arrange this, orient them at right angles or place a grounded wire or shield between the input and output wires/components that can't be properly spaced. Strange high-frequency oscillations may occur otherwise.

b) Leave room around tubes, plate load resistors, and other parts which will get hot for air cooling and to keep from overheating adjacent parts. Do not position large coupling caps or electrolytics next to tubes. A minimum spacing of 3/4" is recommended.

c) If your project requires two identical circuits (e.g. a stereo preamp) lay them out exactly the same way! This will keep stray capacitances equal and ensure identical behavior across the entire bandwidth of the circuit.

2) Lay out the circuit and its boundaries on graph paper. Use one color for the components and another color for the connecting wires. A black dot, 1/8" to 1/4" from the body of axial resistors and caps, should be drawn on the layout to signify where the components lead passes through the board. Radial components can have leads pass through the board directly under the component or you can bend the leads out to any desired spacing. Place black dots at hole-centers where mounting hardware and tube sockets will require drilling.

3) Place the actual components on the paper template to verify that your spacings are correct.

4) Juggle the size of the board and component placement until all components fit properly and layout is optimized.

5) Cut out the layout template and tape it to a piece of teflon of the desired size.

6) Push an awl or other sharp pointed tool through the black dots made in step #2 to make an indentation in the board material which can be seen after the paper is removed.

7) Use a 1/16" drill bit to drill holes for all components. Use *only* paddle bits (flat wood bits) for drilling tube socket holes (3/4" paddle bits for 9-pin sockets). Be careful, though. If you get sloppy and let the bit wobble too much, you'll drill away the material you intended to mount the socket on. A 5/32" drill bit is just about the right size for drilling holes for #6-32 mounting hardware including an appropriate fudge factor. A 1/8" bit is a good choice for 4-40 hardware for mounting 9-pin sockets.

8) Install eyelets. Eyelets are not strictly necessary but they are a nice option. They are good mechanical anchors and allow the use of recycled components with short leads.

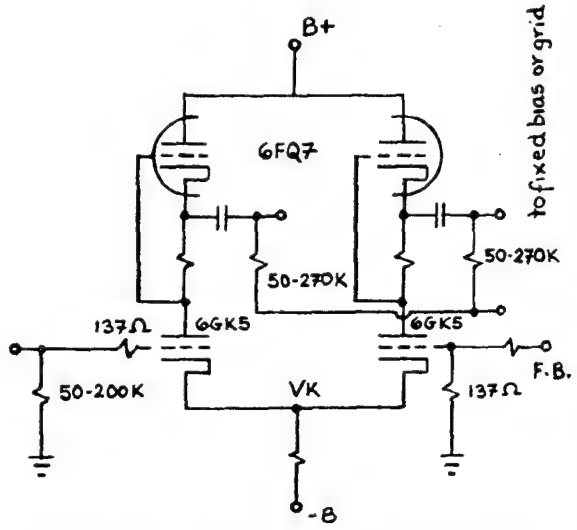
9) Install components. Use component leads to make connections whenever possible rather than jumper wires. When not feasible, use your favorite small diameter (less than 20 ga.) hookup wire and WRAP IT AROUND the component lead no less than 270 degrees. 360 degrees is even better. A good mechanical joint is essential for a good electrical connection. Make it so that it would be a solid contact even if you forgot to solder the joint.

10) Hook the completed circuit board up to the rest of your project and enjoy.

NOTES ON THE SAMPLE CIRCUIT

The boards pictured here were built by a friend for use in a Dyna MK III. It is a good sounding driver stage suitable for a wide variety of push-pull applications, including all of the popular pentode outputs and triodes like the 300B, 2A3/6B4-G, etc.

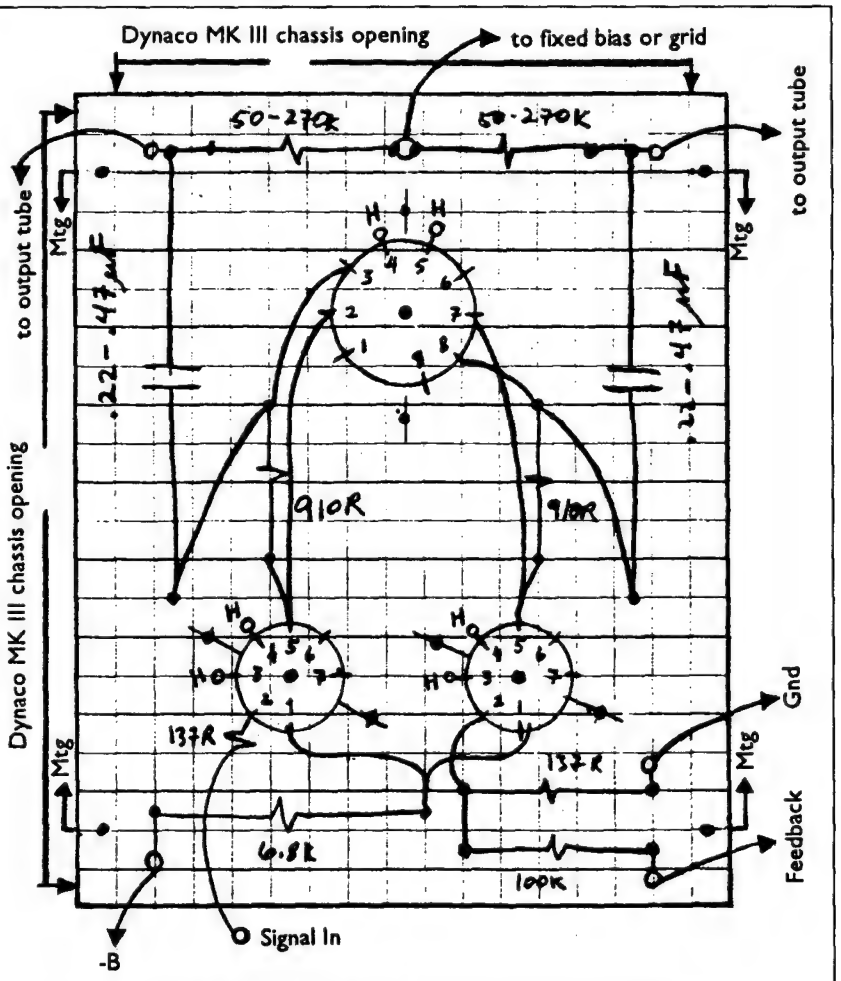
The 6GK5 is a 1960's design very low noise high mu triode designed for VHF applications. One could use all 6GK5s in the diff amp but then the coupling caps won't fit on a MK III sized board. The dual section 6FQ7 was employed as a space saving measure. Distortion figures are for the circuit given below. With all 6GK5s,



Here's a useful circuit: a SRPP differential amplifier driver stage.

B+ = 390 V, B- = -112V, Vk = 1.5V, RI = 49.5K
GAIN = 26DB Z out = 2K Ohms

PEAK TO PEAK SWING	%THD
20 Volts	0.07
40	0.17
60	0.34
80	0.61
100	1.05
120	1.66



This is a layout to scale for a Dyna MK III driver board

the B+ is 350V and the output impedance is 1800 ohms. This circuit would also be useful for converting single ended preamps to balanced output.

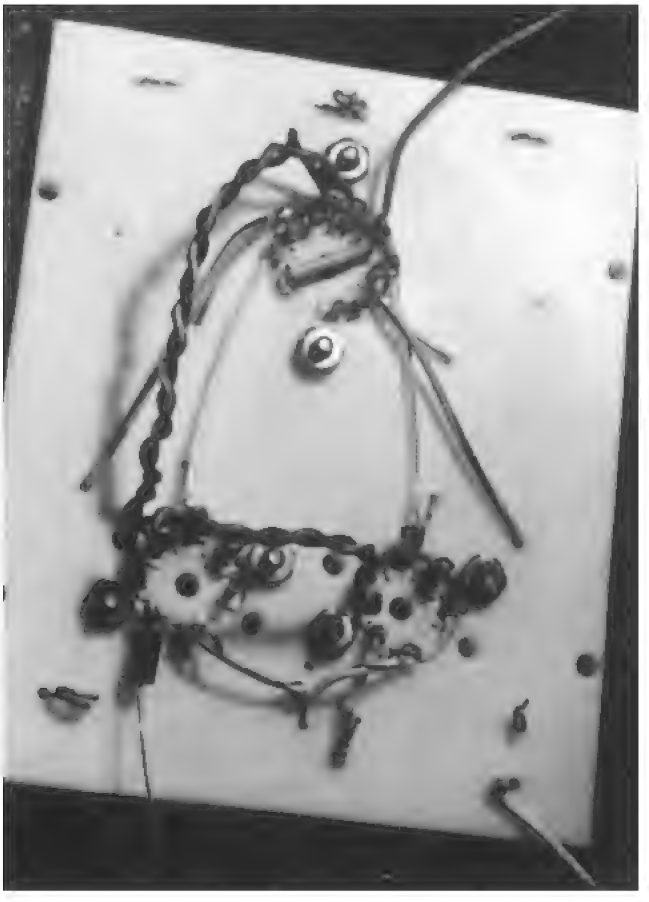
This article is really about making boards. However, if you are interested in giving this circuit a try in a Dyna or elsewhere, I can provide a collection of tube data and other application notes. Please write me c/o Clarus Recording Products at the address below and include $3.00 with your request to help cover copying and mailing costs.

REFERENCES ON TEFLON CAPS

1. Jung, W.G. And R.N. Marsh "Picking Capacitors, Parts I & II", *AUDIO* February and March 1980.
2. Curl, J. and W. Jung, "A Real-time Signal Test for Capacitor Quality", *THE AUDIO AMATEUR* 4/85
3. Component Research, Inc., *Selection guide*, EEM, Hearst Business Communications, Inc., 92/93.
4. Pease, R.A., "Understanding Capacitor Soakage to Optimize Analogue Systems", *ELECTRONICS WORLD + WIRELESS WORLD* October 1992.

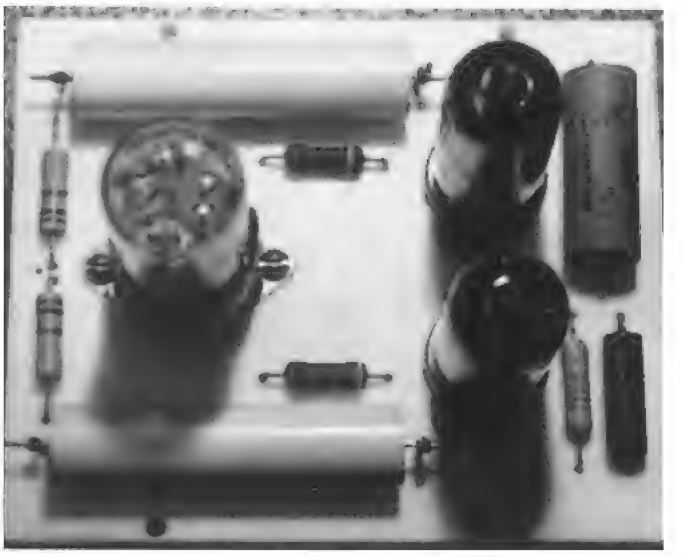
WHERE TO GET TEFLON

To find a local Teflon supplier check your local phone book under "Gasket Supplies". "Teflon" is a trademark of Dupont, Inc.



Two views of completed MK III driver board illustrating construction techniques discussed in text.

[Photos by John Conarton]



APPENDIX - USEFUL RESISTOR DATA

TYPE	LEAD SPACING	WATTAGE		MAX V	TC
RN55	1/2"	0.125	*	200	25-100
RN60	5/8"	0.25	*	250	25-100
RN65	7/8"	0.50	*	300	25-100
RN70	1- 1 1/4"	0.75	*	350	25-100
RN75	1 3/8"	1.0	#	500	25-100
RN80	2 9/16"	2.0	?	750 ?	25-100
Vishay					
S102K	0.150"	0.4- .6	*+	300	1.5
S102C	0.150"	0.4- .6	*+	300	2.3
VTA54	1"	0.5	*	300	8.0
Holco H4	9/16"	0.25	*	300	5-100
Resista MK2	1/2"	0.6	@	350	50-100
MK4	7/8"	1.0	@	500	50-100
MK8	1"	1.5	@	500	50-100
Caddock					
MK120	0.150	0.5	#	200	50
MK132	0.200	0.75	#	400	50
Hymeg HN-2	3/4"	0.60	*	1000	25-100
1W Flameproof	3/4"	1.0		350	200
2W Flameproof	7/8	2.0		350	200

NOTES:

Temperature coefficient (TC) in parts-per-million per degree C

* Military rating at 70 C, usually half of commercial rating

\+ 1-100 k ohm are 0.6 W, >100-250 k ohm units are rated 0.4W

\# Rating for 125 C ambient

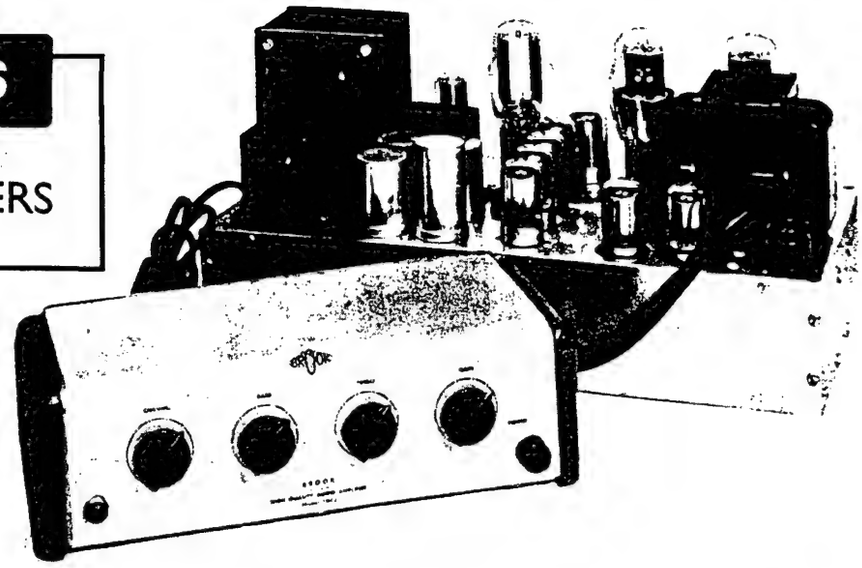
@ Commercial 70 C rating

THE AUTHOR

Mike VansEvers is trained in Geology but prefers rock music to the igneous variety. He builds and modifies microphone preamps, signal processors, and other recording studio equipment for Clarus Recording Products in Tampa. At present, he is researching noise in audio systems and he welcomes communication on this topic. You can write to Mike c/o Clarus Recording Products at 1248 E. Hillsborough Ave., Suite 200, Tampa, FL 33611.

CLASSIC DESIGNS

THE BROOK AMPLIFIERS



The Brook amplifiers were landmark products in the evolution of audio. Designed in 1947 by Lincoln Walsh, the 30 watt Brook 10C and the Model 12A, its lower powered sibling, were among the finest amplifiers available at the dawn of the Hi-Fi era in the years after WW II. There was also a Brook integrated amp (Model 22A) based on the 10 watt 12A circuit.

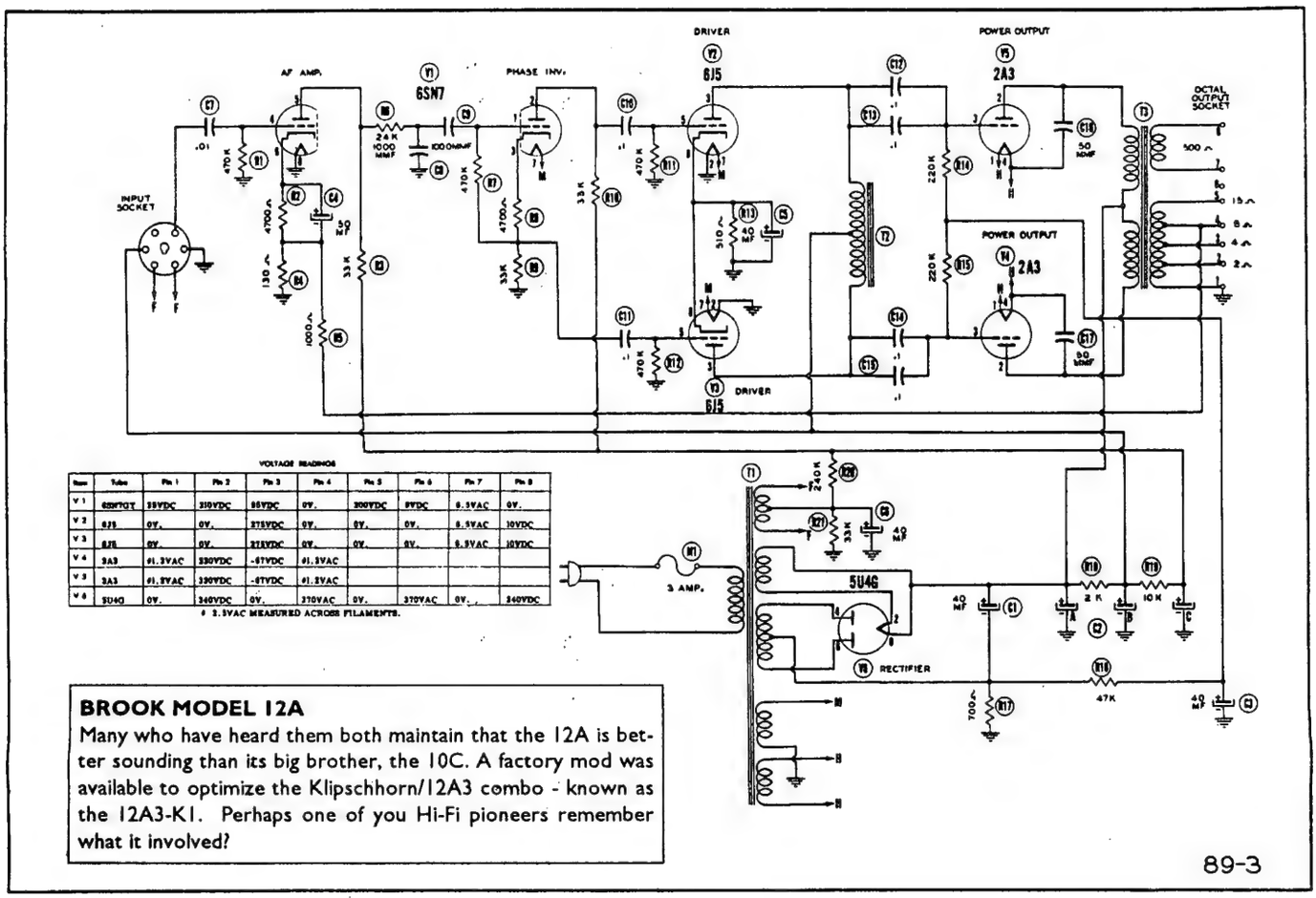
A Brook and a Klipschhorn or JBL horn system would put you in the Editor's Choice circle back in '51. The Brooks were Paul Klipsch's reference amplification.This was High End before there was High End. The Brooks are still favorites among collectors and discriminating listeners of vintage gear.

Lincoln Walsh clearly recognized the importance of proper design of the driver circuitry in a high quality amplifier. The driver in the 10C is configured as a transformer coupled cathode follower for a low impedance source of grid drive. Note that the transformer is shunted by high value caps for extended low frequency response, a tactic later employed in the Fisher 50A. Brook amps use fixed bias supplies for maximum output and low measured distortion.

he 10C features a novel automatic bias circuit patented by Walsh before the war. Varying the grid bias of the 6J5 cathode follower driver effectively controls the gain and load impedance of this tube in response to changing signal conditions - maximum gain under class A operation and lower impedance and gain under conditions of grid current. For further reading on the 10-C, see "High-Quality Audio Amplifier with Automatic Bias Control" in *Audio Engineering*, June 1947.

The Brook marketing campaign clearly targeted the "Triode Freaks" of the day. As the sales literature for the model 22A put it: "Low mu triodes, employed exclusively in the Brook amplifiers, are used

(continued p. 20)

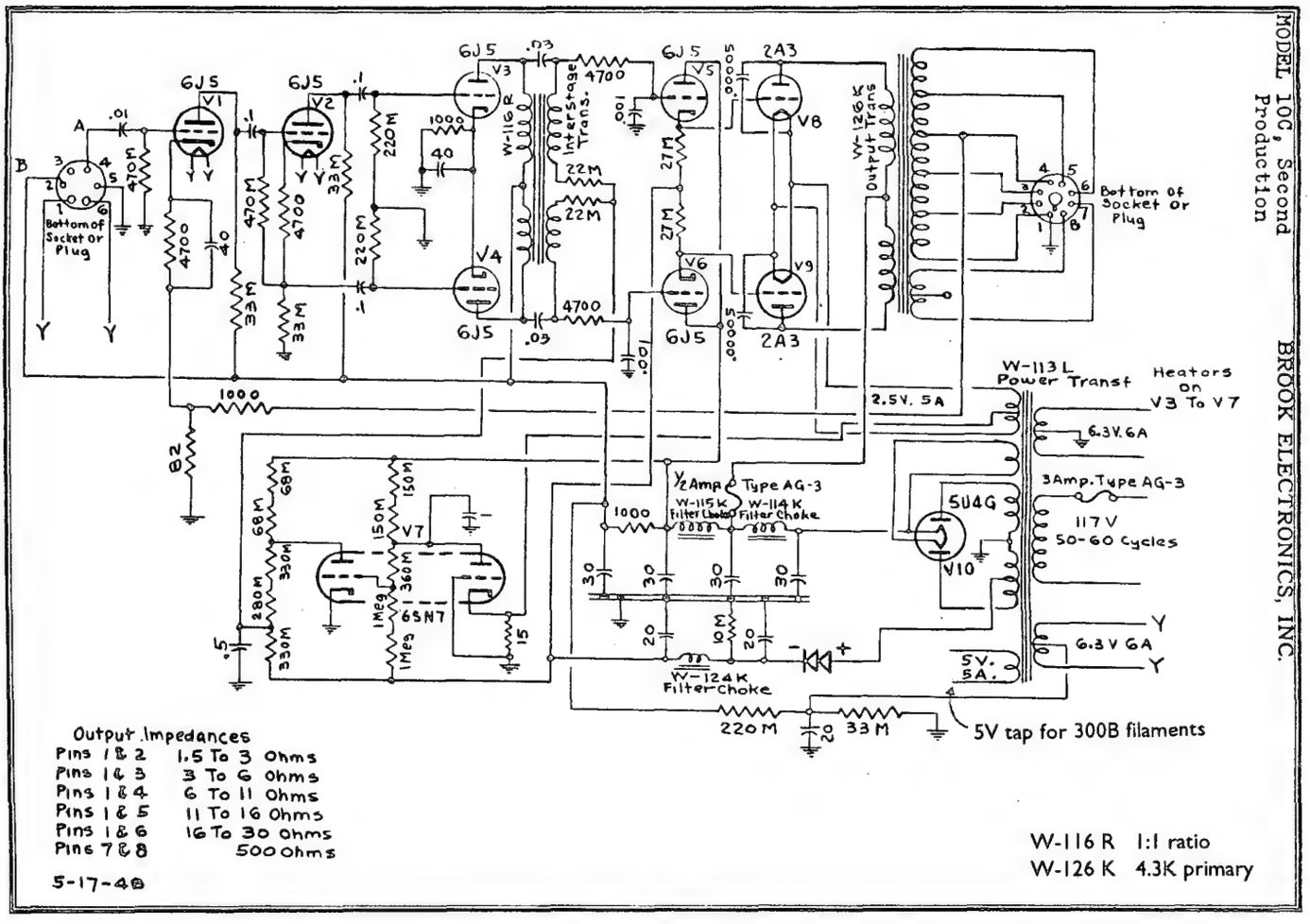


Item	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
V 1	6SN7GT	55VDC	310VDC	85VDC	0V.	300VDC	8VDC	6.3VAC	0V.
V 2	6J5	0V.	0V.	275VDC	0V.	0V.	0V.	6.3VAC	10VDC
V 3	6J5	0V.	0V.	275VDC	0V.	0V.	0V.	6.3VAC	10VDC
V 4	2A3	41.3VAC	330VDC	-67VDC	41.3VAC				
V 5	2A3	41.3VAC	330VDC	-67VDC	41.3VAC				
V 6	5U4G	0V.	340VDC	0V.	370VAC	0V.	370VAC	0V.	340VDC

* 2.5VAC MEASURED ACROSS FILAMENTS.

BROOK MODEL 12A

Many who have heard them both maintain that the 12A is better sounding than its big brother, the 10C. A factory mod was available to optimize the Klipschhorn/12A3 combo - known as the 12A3-K1. Perhaps one of you Hi-Fi pioneers remember what it involved?



TYPICAL DISTORTION ANALYSES

POWER OUTPUT	MODEL 12A 10-WATT 2 WATTS	5 WATTS	10 WATTS	MODEL 10C 30-WATT 2 WATTS	10 WATTS	20 WATTS	30 WATTS
†INTERMODULATION (%)	.67	1.40	2.56	.97	1.24	1.22	1.69
HARMONIC DISTORTION (%)							
2nd	.08	.05	.12	.025	.24	.39	.55
3rd	.03	.24	1.10	.14	.23	.80	.30
4th	*	.025	.09	.005	.005	.05	.06
5th	.005	.03	.40	.03	.04	.39	1.10
6th	*	*	.07	*	.01	.02	.01
7th	*	.005	.21	*	.02	.04	.19
8th	*	*	.05	*	*	.005	.06
9th	*	*	.11	*	.005	.08	.25
10th	*	*	.04	*	*	.005	*
Total (RMS)	.086	.25	1.21	.15	.34	.98	1.30

† Intermodulation tests made with 60-cycle and 7000-cycle tones on 30-watt amplifier, and with 100-cycle and 7000-cycle tones on 10-watt amplifier, the 7000-cycle tone measuring 12 db below the low frequencies. The intermodulation percentage figures represent the ratio to the 7000-cycle tone of the rms sum of all intermodulation products. Measurements made with Hewlitt-Packard Wave Analyzer Model 300-A.
* Not measurable — less than .005%.

SPECIFICATIONS

	10-WATT POWER AMPLIFIER MODEL 12A	30-WATT POWER AMPLIFIER MODEL 10C
FREQUENCY RANGE:	20 to 30,000 cycles within 0.5 db	20 to 30,000 cycles within 0.2 db
POWER OUTPUT:	10 watts	30 watts
OUTPUT IMPEDANCES:	2, 4, 8, 16-ohms grounded and 500-ohms ungrounded	2, 4, 8, 16 ohms grounded and 500 ohms ungrounded
POWER CONSUMPTION:	110 watts at 117 volts, 50-60 cyc'es AC	125 watts at 117 volts, 50-60 cycles AC
GAIN:	55 db flat	55 db flat
INPUT IMPEDANCE:	500,000 ohms	500,000 ohms
TUBES (all triodes)	2-2A3, 1-6SN7, 2-6J5, 1-5U4G	2-2A3 (or 300B) 1-6SN7, 6-6J5, 1-5U4G
DIMENSIONS:	17" x 6¾" x 8½" high	17" x 8" x 8½" high
NET WEIGHT:	18 lbs.	34 lbs.
HUM LEVEL:	More than 75 db below full output	More than 75 db below full output
POWER AVAILABLE FOR TUNER:		90 MA DC at 280V DC; 4A at 6.3V AC

DAMPING FACTOR

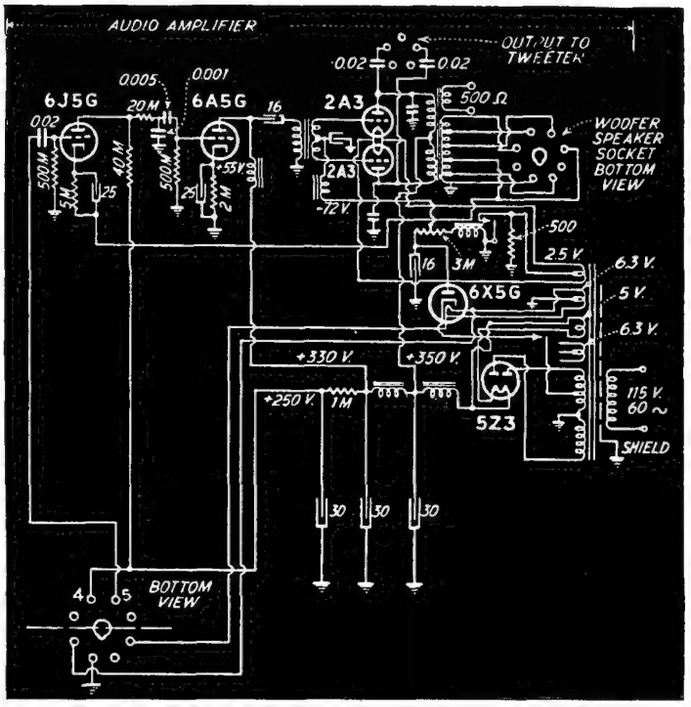
Applies to both 12A and 10C The output impedance on the 8-ohm tap is .8 ohms, giving a damping factor of 10. The other speaker taps have about the same damping factor.

The 500-ohm line has an output impedance of approx. 90 ohms, giving a damping factor of approx. 5.5.

TRANSIENT PEAK CIRCUIT

This Brook circuit development enables the 12A series of amplifiers to handle power peaks considerably higher than their ten-watt rating, at the same time holding distortion within the values shown above. This ability to handle peak transients for about half a second without increased distortion is a major factor in making the 12A amplifier a cleaner and more useful amplifier than its ten-watt rating would indicate

The automatic-bias-control (ABC) circuit used in the 30-watt Brook Amplifier more than doubles the power output and efficiency of the output system, at the same time greatly reduces harmonic distortion. The circuit automatically holds the plate current at small signal very rigidly to normal value, but permits the plate current to rise to the large values needed at high power output. The amplifier operates in Class A up to about 5 watts, and then there is a smooth transition to Class AB2 operation at maximum power of 30 watts.



The grandfather of the Brook Amps: This is the audio amp of a "high quality" radio receiving system designed by Lincoln Walsh which appeared in *ELECTRONICS*, July 1939. Because of the low impedance driver stage, the fixed bias Class A prime circuit is claimed to deliver 30 watts peak at low distortion.

← The "natural harmonics" argument for triodes was probably already showing its age by the time the Brooks came along

BROOK AMPS (continued from p.18)
to give the listener the smoothest, most NATURAL sound reproduction possible. The problem of "listening fatigue, a disturbing by-product of many audio amplifiers, is eliminated as the triode circuit gives far less distortion of the higher order harmonics." Brook amps, according to the author of the 1947 article noted above, are free of the "strong desire to stop listening" which the high order harmonic distortion of pentode and beam tube feedback amps induce.

It should be noted that the 10C provided extra filament taps so that the amp could be connected for 300B outputs! The Fairchild 620 recording amplifier, an OEM version of the 10C with regulated B+ on the input and driver stages, allowed for use of not only 2A3 and 300B but also 6B4G outputs -- 3 different filament voltages! (see Read, Oliver, *Recording and Reproduction of Sound*, Sams, 1952, p.621).

The 10 C was intended for use in broadcast and recording applications, PA systems as well as in "homes where the finest music and voice reproduction is desired." You could do worse even today.



Brook ad from October 1949



Meet the Tube . . .
THE TRUSTY 807

The 807 came along at just the right time. Shortly after its introduction in 1936, it was catapulted into celebrity by the tides of world history. World War II swiftly created a huge demand for a rugged, stable, efficient, low cost, and versatile tube for communications uses. The 807 was as close to a perfect solution to that set of challenges as we have ever known.



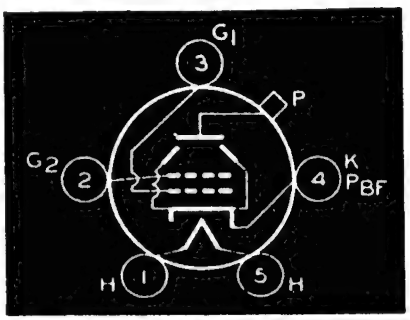
It was a tube for many purposes. The 807 was rated for Class A, AB1, AB2, & B audio service and Class B and C RF amplifier service. Its mastery of many disguises earned the 807 the title "The Little Magician" in the 1941 *RCA Guide for Transmitting Tubes*.

Luckily for succeeding generations of radio hams and audio experimenters, the 807 and its 12.6V, 7 pin brother, the 1625/VT-136 , were produced in such quantities during the war that the availability of cheap NOS surplus samples would be ensured well into the 21st Century. Some military transmitters used them for both modulator and RF power amp stages because it was easy to drive, not overly prone to spurious oscillation, and highly efficient. It is usually provided with a brown Micanol low-loss base but ceramic based units also exist.

Although they were used in many medium-priced PA amplifiers and in Altec and Westrex commercial gear, the 807 was never as popular in home Hi-Fi gear as other beam tubes like the 6L6, 5881, KT66, and 1614. Perhaps the exposed B+ on the plate cap argued against its use in the living room. It was specified in American versions of the British Williamson design in lieu of the KT66 and it was featured triode connected in some early Heathkit and Grommes Williamson-type amps.

With the dwindling supply and rising prices of primo beefy beam output tubes nowdays, perhaps the 807 is due for a revival. Just keep cats and children away from those plate caps!

Bottom View of Socket Connections



Tube Mounting Position
VERTICAL or HORIZONTAL

EQUIVALENTS

807W	Ruggedized Version
5933	" "
RK39	Raytheon
HY61	Hytron
350A	Western Electric
T-21	Taylor
VT-100	Military VT number

RCA

807

BEAM POWER TUBE

Useful at Frequencies up to 125 Mc

GENERAL DATA

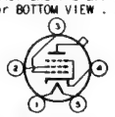
Electrical:

Heater, for Unipotential Cathode:		
Voltage	6.3 ± 0.6	ac or dc volts
Current	0.9	amp
Transconductance (Approx.) for plate volts = 250, grid-No.2 volts = 250, grid-No.1 volts = −14	6000	μmhos
μ-Factor, Grid No.2 to Grid No.1 for plate volts = 250, grid-No.2 volts = 250, and grid-No.1 volts = −20	8	
Direct Interelectrode Capacitances:		
Grid No.1 to plate[G]	0.2 max.	μμf
Grid No.1 to cathode & grid No.3, grid No.2, and heater	12	μμf
Plate to cathode & grid No.3, grid No.2, and heater	7	μμf

Mechanical:

Mounting Position	Any
Maximum Overall Length	5-3/4"
Seated Length	4-31/32" ± 5/32"
Maximum Diameter	2-1/16"
Weight (Approx.)	3 oz
Bulb	ST-16
Cap	Small (JETEC No.C1-1)
Base . . . Medium-Micanol-Shell Small 5-Pin (JETEC No.A5-11)	
Basing Designation for BOTTOM VIEW	5AW

Pin 1 – Heater
Pin 2 – Grid No.2
Pin 3 – Grid No.1
Pin 4 – Cathode, Grid No.3
Pin 5 – Heater
Cap – Plate



AF POWER AMPLIFIER & MODULATOR – Class AB1[φ]

Triode Connection—Grid No.2 Connected to Plate

Maximum Ratings, *Absolute Values:*

	CCS[◇]	ICAS[◇◇]	
DC PLATE VOLTAGE	400 max.	400 max.	volts
MAX.-SIGNAL DC PLATE CURRENT*	125 max.	125 max.	ma
MAX.-SIGNAL DC PLATE PLUS GRID-No.2 INPUT*	50 max.	50 max.	watts
PLATE DISSIPATION PLUS GRID-No.2 INPUT*	25 max.	30 max.	watts

Typical Operation:	CCS[◇]			ICAS[◇◇]	
Values are for 2 tubes					
DC Plate Voltage	400	500	600	750	volts
DC Grid-No.2 Voltage**	300	300	300	300	volts
DC Grid-No.1 (Control-Grid) Voltage: *From fixed-bias source*	−28	−30	−32	−35	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	80	86	90	96	volts
Zero-Signal DC Plate Current	72	60	48	30	ma
Max.-Signal DC Plate Current	240	240	200	240	ma
Zero-Signal DC Grid-No.2 Current	2	0.9	0.7	0.5	ma
Max.-Signal DC Grid-No.2 Current	20	20	18	20	ma
Effective Load Resistance (Plate to plate)	3700	4600	6900	7300	ohms
Max.-Signal Driving Power (Approx.)[◇◇]	0.2	0.2	0.1	0.2	watt
Max.-Signal Power Output (Approx.)[A]	55	75	80	120	watts

Maximum Circuit Values (CCS or ICAS):

Grid-No.1-Circuit Resistance:[◇◇]	
With fixed bias	30000 max. ohms
With cathode bias	Not recommended

AF POWER AMPLIFIER & MODULATOR – Class AB1[φ]

Maximum Ratings, *Absolute Values:*

	CCS[◇]	ICAS[◇◇]	
DC PLATE VOLTAGE	600 max.	750 max.	volts
DC GRID-No.2 (SCREEN) VOLTAGE	300 max.	300 max.	volts
MAX.-SIGNAL DC PLATE CURRENT*	120 max.	120 max.	ma
MAX.-SIGNAL DC PLATE INPUT*	60 max.	90 max.	watts
MAX.-SIGNAL GRID-No.2 INPUT*	3.5 max.	3.5 max.	watts
PLATE DISSIPATION*	25 max.	30 max.	watts
PEAK HEATER-CATHODE VOLTAGE: Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts

Typical Operation:	CCS[◇]			ICAS[◇◇]	
Values are for 2 tubes					
DC Plate Voltage	400	500	600	750	volts
DC Grid-No.2 Voltage**	300	300	300	300	volts
DC Grid-No.1 (Control-Grid) Voltage: *From fixed-bias source*	−30	−32	−34	−35	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	60	64	68	70	volts
Zero-Signal DC Plate Current	56	44	36	30	ma
Max.-Signal DC Plate Current	143	141	139	139	ma
Zero-Signal DC Grid-No.2 Current	2	1	0.6	0.5	ma
Max.-Signal DC Grid-No.2 Current	16	15	15	16	ma
Effective Load Resistance (Plate to plate)	6800	8200	10000	12000	ohms
Max.-Signal Driving Power (Approx.)	0	0	0	0*	watts
Max.-Signal Power Output (Approx.)	36	46	56	72	watts

Maximum Circuit Values (CCS or ICAS):

Grid-No.1-Circuit Resistance:[◇◇]	
With fixed bias	0.1 max. megohm
With cathode bias	Not recommended

New WILLIAMSON TYPE

Heathkit AMPLIFIER KIT

AMPLIFIER Features

- First Williamson Type Amplifier supplied with matching preamplifier
- Uses Altec Lansing Peerless output transformer.
- Practically distortionless — Harmonic and intermodulation distortion both less than ½ of 1% at 5 watts output.
- Frequency response ± 1 db from 10 cycles to 100 kc.
- Output impedance 4, 8, or 16 ohms.

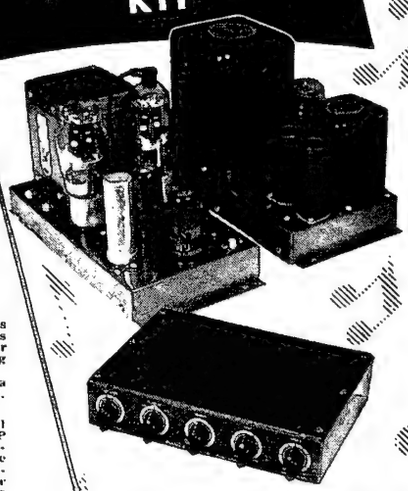
The new Heathkit Williamson Type Amplifier kit is the best obtainable in amplifiers today — the choice of the really discerning listener. You can hear the difference and measurements actually bear out the superb performance. Frequency response ± 1 db from 10 cycles to 100 kc allow you to hear the highs and lows with equal crispness and clarity. Harmonic and intermodulation distortion both less than ½ of 1% at 5 watts output eliminate the harsh and unpleasant qualities which contribute to listening fatigue.

The circuit is similar to the one published in Audio Engineering Magazine for November, 1949, and is considered by engineers throughout the audio field as one of the best ever developed. The Main Amplifier (which may be purchased separately) consists of a voltage amplifier and phase splitter using a 6SN7, a driver stage using a 6SN7, and a push-pull output stage using a pair of 807 tubes. The output transformer is manufactured by the Peerless Division of Altec Lansing and is built to their highest standards. Output impedances of 4, 8, and 16 ohms are available. The power supply uses a separate chassis with husky Chicago Transformer power transformer and choke, and 700V Mallory filters for long hum-free operation. A 5V4G rectifier is used.

The main amplifier and power supply are each on a chassis measuring 7" high by 5½" wide by 11" long.

PREAMPLIFIER AND TONE CONTROL UNIT KIT

The preamplifier kit consists of: a 12AX7 (or 12AY7) dual triode first amplifier stage with a turn-over control for LP or 78 record types, and a 12AU7 amplifier stage with individual bass and treble tone controls which each provide up to 15db of boost or attenuation. A switch on panel selects either magnetic, crystal, or tuner inputs. Preamplifier also is well suited to custom installations — it will operate in either vertical or horizontal position, and special notched shafts of the controls and switches allow a variety of shaft lengths to be selected. Dimensions: 2¼" high by 10¼" wide by 7¼" deep.



WA-A1 Amplifier kit — Combination 1 — (Main Amplifier and Power Supply) complete with WA-P1 Preamplifier kit. Total Ship. Wgt., 34 lbs. (Shipped Express only) **$69.50**

WA-A1 Amplifier kit only — Combination 4 — (Main Amplifier and Power Supply). Less WA-P1 Preamplifier. Total Ship. Wgt., 29 lbs. (Shipped Express only)..... **$49.75**

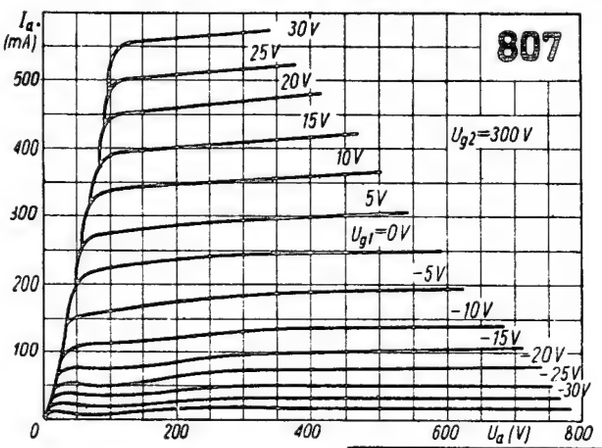
WA-P1 Preamplifier Kit only. (less power supply) (Tubes included). Total Ship. Wgt., 7 lbs. (Shipped Express or Parcel Post)..... **$19.75**

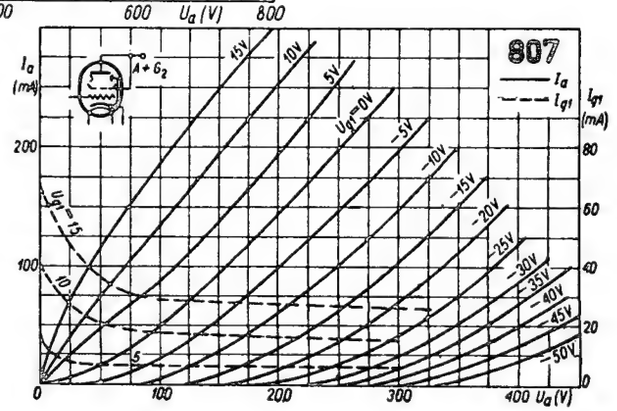
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The HEATH COMPANY
BENTON HARBOR 8, MICHIGAN

You SAVE BY ORDERING DIRECT

An 807 based Williamson Amplifier - Summer 1952





Curves for 807 triode connected

The Core Issues:

Understanding Output Transformers
Part 1 of a series

by Michael S. LaFevre, MagneQuest

"The Core Issues" will examine the function, construction, design, and operation of magnetics for audio applications. This series will combine practical advice in the form of useful "rules of thumb" with enough pure theory to give us some concept of how these magnificent devices work. This column is not an academic engineering tutorial but rather a guide to becoming an informed consumer.

In all of the audiophile kingdom, there is nothing more shrouded in mystery than the design and operation of output transformers. Many otherwise competent designers and audiophiles relegate the transformer art to the domain of "black magic." Over the next few installments of "The Core Issues", I plan to explore how outputs work and how these devices can be best utilized. Using plain language and practical examples wherever possible, I hope to shed some light on the mysterious goings on deep inside your transformer can. Hopefully, I'll be fortunate enough to successfully debunk a few myths along the way.

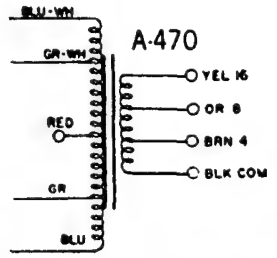
ASSUME AN IDEAL TRANSFORMER

As we did in our installment on power transformers in *Sound Practices* #1, lets begin our journey on the conceptual and ideal plane. An ideal output transformer would have no losses of any kind, it would have an infinite amount of primary inductance, it would have no leakage inductance and no capacitances of any kind. Its bandwidth (frequency response) would be as wide as any incoming signal and it would not cause any phase shifts or other anomalies which hamper the performance of real world transformers. An ideal transformer would be one that simply and perfectly either steps up or steps down voltages and currents in accordance with Ohm's Law.

To illustrate the operation of output transformers, let's use an idealized version of the Dynaco Stereo 70 output transformer (A-470) as an example. In most applications the designer will first select a primary impedance that will provide the optimum "load" that the output tubes should work into. This question is itself a subject of great interest and debate among circuit designers but for purposes of illustration let's assume our example provides an acceptable value for the tube type employed and its particular operational parameters. Early on the designer will also specify the working power level of the transformer as well as the secondary impedances -"output taps"- that must be provided.

In the case of our idealized Stereo 70 transformer, the primary impedance is 4300 ohms and it has a secondary that will provide for termination to a 4, 8, or 16 ohm load. Its maximum operating level (when it was first designed) is 35 watts. Of course, the poor ST-70 transformer has often been pressed into service under far from 'ideal' conditions in the afterlife by designers of 50 watt amps... but let's not throw stones.

Ideal Dynaco A470 @ 35 Watts output



PRIMARY		SECONDARY
4300ohms	Impedance	16ohms
268.8	Impedance ratio	1
16.4	Turns/voltage ratio	1
387.9 V	AC signal volts	23.7 V
0.09 A	AC signal current	1.48 A

If we view outputs as pure *step up* or *step down* devices we can see that they are inherently simple ratio devices. What you do on one side of the transformer determines absolutely what happens on the other side of the transformer and can be described solely through Ohm's law. The ST-70's output trans is, as most output transformers are, a *step down* device. In this case we want to transform or change the primary windings' relatively high voltage/low current electrical energy into a lower voltage/higher current energy level necessary to drive a speaker voice coil.

Using Ohm's Law we can calculate the voltages and currents of the primary winding. The primary AC voltage (E1) can be worked out as follows:

$$E_1 = \sqrt{Z_1 \times W}$$

E_1 *primary voltage*
Z_1 *primary impedance*
W *output power level*

In our example, the primary AC voltage level works out to be 387.94 Volts RMS.

The AC signal current (I_1) can be derived through the following equation:

$$I_1 = E_1 / Z_1$$

The result being 0.09 A (or 90 milliamps). To double check, remember that the AC primary voltage multiplied by the primary AC current must equal the power level calculated above.

Let us next calculate the secondary voltage and current.

$$E_2 = (\sqrt{E_1^2 \times Z_2}) / Z_1$$

The secondary currents are calculated by:

$$I_2 = (I_1 \times E_1) / E_2$$

So the secondary voltages and currents of the ST-70 output are the following:

Impedance	Voltage	Current
4	11.8	2.96
8	16.7	2.09
16	23.7	1.48

Again, to double check multiply the secondary currents and voltages together and you should get the power level of the transformer or 35 Watts. From the information

we have so far we can determine that the power level of the primary exactly equals the power level of the secondary. This illustrates the first real lesson of transformers of any type - ***Transformers Are Not Amplifiers***. A transformer cannot deliver more power than that which is impressed on its primary winding. Ideal models show the same amount of power on both the primary and secondary sides. In all real world designs, there will always be less power delivered to the secondary than is present in the primary winding because of iron and copper losses.

What our idealized ST-70 output does illustrate is that voltages and currents can be "transformed" or changed from primary to secondary. The voltage ratio of the full primary to the full secondary can be stated as 387.9433 : 23.6643 or, in a more handy reduced form, 16.4 : 1.

In an ideal transformer (of any type) *the turns ratio will be exactly the same as the voltage ratio.* Therefore, in our idealized ST-70 the output transformer will have 16.4 turns of magnet wire on the primary side for every one turn of wire on the secondary. If we properly terminate the secondary with a 16 ohm load, then for every volt impressed on the primary winding there will be just .06 volts on the secondary but at much higher current.

IMPEDANCE

So far we have been speaking of voltages and voltage transformation. Most audiophiles are much more accustomed to discussions that use the "impedance" language in discussing output transformers. It is very rare indeed that an output transformer is specified on a voltage basis although it would be perfectly legitimate to do so. This is because the impedance ratio (in our example 4300 ohms : 16 ohms) is nothing more than the voltage ratio (or, alternatively, the turns ratio) squared.

turns ratio = voltage ratio
impedance ratio = voltage ratio squared
impedance ratio = turns ratio squared

Conversely, we have the familiar formula relating turns ratio and impedance ratio:

$$N_1 / N_2 = \sqrt{Z_1 / Z_2}$$

N *number of turns*
Z *impedance*

Hence, the impedance ratio of our idealized output trans is 268.8 : 1. And if we load the secondary with 16 ohms we will reflect back onto the primary 4300 ohms. Listed below are the impedance and voltage ratios of the secondary windings for our idealized example.

Secondary	Impedance ratio	Turns ratio
4	1074.9 : 1	32.8 : 1
8	537.5 : 1	23.2 : 1
16	268.8 : 1	16.4 : 1

Note that you can always calculate the primary impedance by multiplying the load placed on the secondary by the appropriate impedance ratio. *In other words, the primary impedance is fully determined by the secondary load and the turns ratio.*

MISMATCHING

Suppose we put an 8 ohm load across the 16 ohm tap, then we will have a primary impedance of only 2150 ohms - half of 4300 ohms. By extension, if we put a 4 ohm load across the 16 ohm tap, the impedance reflected to the primary will be only 1075 ohms or just 1/4 the impedance at which the transformer was designed to operate.

In the world of our ideal transformer, changes in the operating impedance would have no adverse impact on the performance of the transformer since we have conveniently eliminated the possibility of real world limitations. May be damn nice but it's simply not very realistic.

Although transformers are "just" ratio devices, not every real world application will yield optimal results. For example, if we put an 8 ohm load across the full secondary (16 ohm tap) on our 35 watt ST-70 transformer the primary current would be 128 ma (@ 274.3 V) and the secondary current would be 2.09 A (@ 18.7 V). The current handling demand on both primary and secondary windings is increased by 30% by this seemingly innocent maneuver!

Most transformers are incapable of handling this increased current demand without measurable diminution in performance characteristics. As current rises, so do net resistance losses in the copper magnet wire. Increased voltage losses cause greater temperature rise within the transformer compromising its efficiency even further. In output transformers, such losses are collectively quantified as *insertion loss*, usually stated in decibels. Certain very conservatively designed transformers can readily cope with 30% increases in current flow but these are rare units indeed.

Once you realize this, you may find it curious that some high end manufacturers have suggested trying different taps and choosing the "one that sounds best". The cautious side of my personality views this suggestion in the same light as the suggestion of the EQ manufacturer who recommends that you slide the treble and balance controls to where they sound "best". How do you know what you're ending up with?

Say you put your JBL Metragons (a 16 ohm load) on your 4 ohm tap, presto, you've just quadrupled the nominal impedance of the primary. Doing this trick on our ST-70 would yield a primary impedance of 17,200 ohms! Let me assure you that on 99.9% of all transformers that I have seen the result of quadrupling the primary impedance by matching "down" while maintaining the same power level would spell total disaster.

The chief limitation on "matching up", e.g. putting an 8 ohm load on a 16 ohm tap, is core saturation. The higher the impedance, the more AC voltage required to obtain a given power level. Once you pass the "knee of the BH curve" gross core saturation quickly sets in. To prevent core saturation and serious magnetically induced harmonic distortion, one must derate the power level of the transformer substantially when matching up.

Hopefully, engineers who suggest trying different taps are familiar with the real world capabilities and limitations of the iron they're using and make this suggestion in full awareness of the specific qualities of their transformer. Just be forewarned that before you can do this with confidence you must 'know your transformer'.

Aside from the basic questions of losses and saturation, other aspects of transformer design are affected by mismatching. The LF cutoff of a transformer is largely determined by the inductance of the primary winding. The higher the primary impedance, the higher the inductance required for a given low end rolloff. The effective inductance may be affected by mismatching since inductance is roughly linear with the magnitude of AC voltage excitation of the iron. At a lower effective primary impedance the AC voltage drive

required to achieve full output is reduced. This reduction will impact on the incremental permeability of the core so that at low listening levels the transformer will produce proportionately less inductance than it would if it is operated at its design centers. Also as you mismatch up, e.g. by putting a 16 ohm load on a 8 ohm lap, you raise the frequency where the lows roll off because the impedance goes up but the inductance does not increase in proportion. Specification of an appropriate transformer for a specific set of conditions is a subtle balancing act.

We will return to the subject of impedance matching and mismatching as we further explore topics such as inductance, flux density, winding resistance, and the like in future installments of "The Core Issues". The point of this intro to a series on output transformers is to show that transformers are ratio devices and the primary impedance is determined by the load which terminates the secondary. Let us also keep in mind that there are limitations on the range of impedances which this ratio devices can be called upon to transform. The caveats which apply to improper matching will be brought under more detailed scrutiny as the series unfolds.

My focus here is solely on the effects of mismatching on the performance of the transformer but mismatching also impacts on the performance of the circuit which feeds into the transformer. A look at few of the equations in Gordon Rankin's article elsewhere in this issue will show that the impedance presented to the output tube at the primary of the output transformer plays an important role in determining the gain of the output stage. Incidentally, the gain, frequency response, and stability of even your "front end" can be adversely impacted by impedance mismatches between the output stage and the primary of the output trans. If the impedance at the primary (load impedance of the output tube) is halved, the gain of the output stage will be decreased and full rated output impossible to attain. Load tolerance of amplifier circuits varies but it is wise to note that the transformer does not function in isolation from the rest of the circuit.

A good *readable* reference relevant to the concerns of the audiophile on the role of primary impedance and its relationship to circuit performance is Technical Monograph #90-9 "Output Impedance Matching" published by the Valve Amplification Company.[1]

I tend to be conservative in my statements (*in print anyway - Ed.*) because I often get to hear widely circulated misinformation about transformers. For example, one manufacturer published a book which had a statement which has (perhaps inadvertently) led many audiophiles to believe that they should put their speaker load across the entire secondary winding so that there would be no portion of the winding left "flapping in the breeze". The indirect assertion was that it is undesirable to have the winding from, say, 8 to 16 ohms go unused and that this in itself would lead to deteriorated performance. With most transformers, the attempted homestyle cure for this "flapping in the breeze" is far worse than the ill it seeks to remedy. *With proper design* regarding the relative positioning and overall arrangement of the secondary windings, unconnected windings will have no negative effect whatsoever on output transformer performance .

Being the little devil that he is, your editor upon review of an earlier draft of this installment of "The Core Issues" brought up that some transformer spec sheets explicitly state that their transformers *can* be operated at half or double their nominally rated design centers. In their 1958 catalog, Peerless Transformers stated that:

> These transformers (*referring to their 20-20 Plus Series*) can be operated between a wide range of impedances because of the numerically large quality factor; nominal power ratings of the transformers change since they are determined by signal voltages across the windings as well as currents through the windings. When *this series* of transformers is operated between impedances which are half the rated value, the power ratings can be doubled. On the opposite extreme, the power rating must be halved when the transformers are operated between impedances which are double the rated impedance. Under these conditions, the insertion losses are also *doubled* or *halved*; this should be considered in application planning.

Please note that this application note was intended to apply *only* for the 20-20 Plus series. The next-in-line 20-20 Series, for instance, does not have the numerically large quality factor of the 20-20 Plus Series and was not recommended for such applications. For the uninitiated, "Quality Factor" is the ratio of inductance to leakage inductance. In the case of the 20-20 Plus Series this was 100,000 meaning that there is 100,000 parts inductance for every single part of leakage inductance. A quality factor of 100,000 is an absolutely amazing stat. Frank McIntosh in his patent application for his unity-coupled transformer proudly stated that his design was notable for achieving a quality factor of 75,000. To put it in context, the calculated quality factor of our loyal friend, the original ST-70 transformer, would be only 20,313. Perhaps it would be best to employ the A-470, as the designers intended, where it performs well.

Note that Peerless recommended that transformers must be rerated when they are "ratioed". And Peerless clearly advised that increased insertion losses would result. The point was that their premium series of transformers were designed with an abundance of current capacity in their copper circuits, allowing some flexibility in the range of impedances they would efficiently match. This would be useful when employing unusual tube types in circuits where there was no direct applicability of one of the other units in the series. But this application strategy was never intended to be used in the manner or for the reasons which some of our contemporaries might suggest.

In summary, the best practical advice I can give at this stage of our inquiry is think through the changes that you are imposing on the circuit and the transformer if you mismatch. In other words, know thy transformer well (both its capabilities and limitations) and know how it interacts with the circuit it's being used in. Don't mismatch a transformer purposely to try to remedy a real or imagined "flaw" of the transformer. Instead, if your transformer does not offer the performance level that you require at its proper operating centers, buy a good quality new or used unit that will meet your requirements without having to resort to shaky remedies. My own experience has been that transformers function best when they are not called upon to be "multipurpose" (that is to say "multiratio") devices but instead are used at their individual optimum operating points. This is invariably the design center around which they were conceived and executed.

Till next time many happy tunes to all.

1- Available from VAC, PO Box 4609, Sarasota, FL 34320 for $3.

A Report from the First Vintage/Classic Audio Fair

Chicago–Wheeling, June 27, 1992

by Kris Wawer

How do you organize a successful vintage audio show? Have you tried all the 'How To' books in the local library? I'll bet you think you can do it yourself; hire a dozen gorgeous models, put ads in all the flashy audio magazines, rent a posh hotel and give the best suites to the exhibitors. All sophisticated people of honor and authority will participate. *Sure*. Zorba the Greek's fragile construction will look as solid as a Mac 275 in comparison.

I've travelled from Nashville to Elgin and from Detroit to Houston in a van loaded with dozens of collectible vintage guitars - displaying, buying, selling, and swapping them at the major guitar shows. I simply *love* these shows. Wonderful collections of guitars and those who collect them. They have an incredible atmosphere - devoted buffs in collecting heaven.

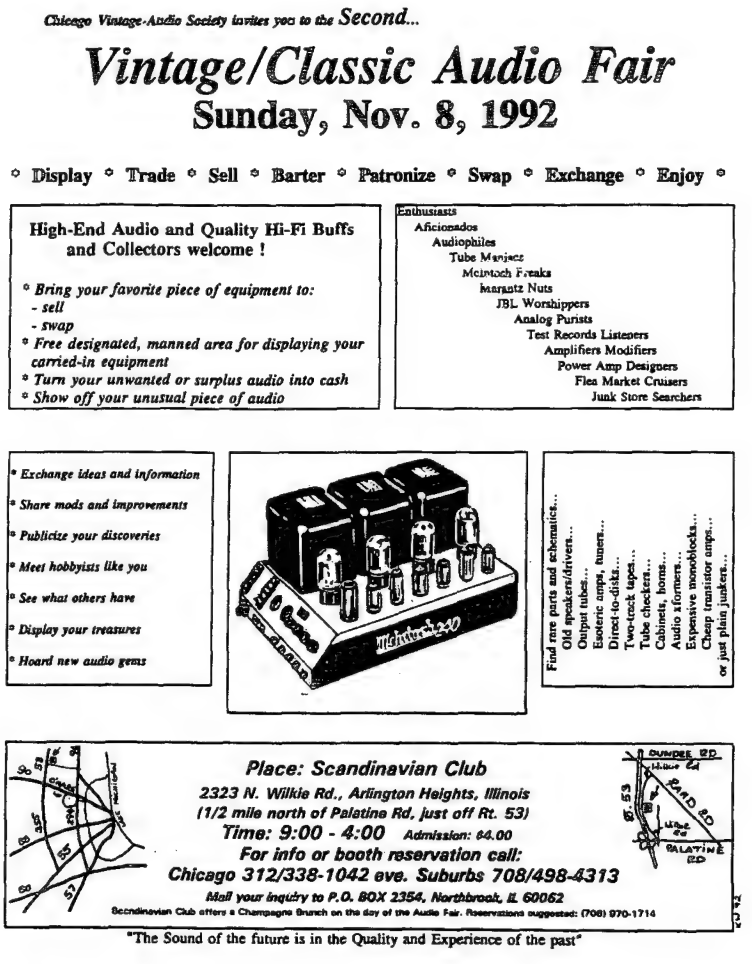
One day, I had the humble thought of organizing a vintage AUDIO show while driving to the spring guitar show in Detroit. I mentioned it to a collecting partner and he immediately suggested "Well, why don't you organize one?" I couldn't think of any quick excuse not to.

Several weeks earlier, I met a local fellow capable of inspiring conversation on a variety of topics in the wide world of audio. Mike Illfelder is well known in the local audiophile circles, he is pleasant and sociable, and he looks like me (which marks him as a very good looking guy indeed). HAH! The ideal co-organizer for the show. After two weeks of constant dialing, I knew his phone number so well, I could recite it at 3:30 AM after a night of jazz clubs and a barrel of single malt scotch. Alas, to no avail ... he was never, ever home.

Luckily, I had other recruits in mind. When the friendly brothers Mike and Dave Schultheis visited one evening, my directness surprised even myself: "Mike and Dave, you don't know it yet but I've decided to organize an audio show and you are in it with me. The decision is final and you cannot refuse! The group contains me, Mike Illfelder and the both of you." Well, I said more- actually, quite a bit more. But it worked! The idea proved infectious and immediately the ball started rolling. Mike Illfelder remained unavailable. We began to suspect he was on a secret CIA mission to a distant country or maybe even as far away as Peoria.

We needed a budget, most of which would be destined for advertising, and some sort of marketing campaign. For the promotional flyer, we needed a high recognition symbol as an eye-catcher. I chose the Mc Intosh 240 and it worked great! People would look at the Mac then scan the text. Often their faces lit up. It was inspiring to see people's reaction to the flyer. Popular reaction was predictable: "*It's about time!*"

Our plan was to recruit vendors from among our fellow audiophiles. Many had extensive, sellable collections of audio treasures. We figured that personal contacts and an ad in Audiomart would attract maybe ten hard core traders. Since there was little lead time before the proposed show date, we were prepared for the worst case scenario - only the three of us would be exhibiting. We decided to set admission at $1.00 so that people wouldn't bitch if we could not 'lure' enough exhibitors to justify a higher entrance fee.



Flyer for the SECOND Vintage/Classic Audio Fair uses the image of a powerful audio icon, the Mac 240, for maximum visual impact and crowd appeal

We needed more help in popularizing the show. Chicago is a *huge* metropolitan area. How do you reach the estimated 2000 audiophiles with a zeal for vintage audio? The budget was limited and the real choices were few. Flyer distribution through record stores, audio outlets, and similar places provided an inexpensive but time intensive medium which would reach the intended audience. Ed Stack offered to canvass the south and southwestern suburbs and distribute the flyer though his network of contacts. He signed on as an exhibitor and did an all around great job of getting the word out. Then Ron Steinberg joined our efforts and swiftly made good on his promise of attracting more exhibitors.

With the show four weeks away, I decided to launch a press campaign. I contacted Audiomart and got encouragement and support from Walt Bender. He had some experience organizing similar types of events on a larger scale and he warned me about some potential mistakes I could make. Walt was also very flexible on terms for payment. I was running low on cash, so Walt took some tubes on trade for the ad, saving my family from starvation. The ad in Audiomart had immediate results. Vendors beyond our local social network began to sign up. It looked like attendees would be getting good value for their one dollar admission after all.

Distributing the flyer to local hi-fi stores, I found that most owners/managers reacted positively. However some were uninterested, unwelcoming, or just plain jerks. One store owner in Chicago jumped on me vigorously, almost shouting and demanding the names and addresses of the people behind it. I goofily responded with all our names then voluntarily added phone numbers and shoe sizes. In the meantime his wife or daughter or whoever entered the arena and doubled his vocal efforts, raising the sound pressure level to about 99 dB. I felt that the stereo separation was excellent, however the left channel had intermodulation distortion caused by aging vocal cords (full identity and address of artist available upon request). I later determined that some store owners let me leave flyers on the counter then threw them away as soon as we left. Peace be with them, poor little people.

The phone rang continuously in response to our advertisements. Some real idiots called with the accusation that we were organizing a conspiracy to sell all our superior American audio goods to a particular rich nation. Yes, it is the truth: Because you are so well informed you force me to admit that we also organized the Second World War and promoted Woodstock Festival to demoralize our youth. Additionally, I am the person who invented Rock and Roll to sink this nation into sin and sexual hell! So be it!

As the big day approached, everything fell into place. Even the insurance company got into the act, quoting us a ridiculous rate to insure the show. We had a paranoid vision of some bozo dropping a power amp on this head and suing us for millions. Better safe than sorry. I put together a little bulletin with some notes, humor, and information on some of the exhibitors involved in the show. I was feeling good and very grateful and I expressed this by sugaring some people beyond the bounds of good taste in the newsletter. I even thought about launching the bulletin as a magazine with a potential worldwide readership of maybe 200 until I figured out that my family didn't have that many members.

The event was held on Saturday; on Friday night I felt that our job was over. We had more exhibitors than we could handle. People were coming from as far as Florida and Canada. I even got a few overseas inquiries but I discouraged them from coming early on in case the show was a flop.

As it turned out, we had about 20 official exhibition tables and more than 20 exhibitors; some shared tables with others. Major Chicago area collectors were present and their tables were full of eye-pleasing audio gear. Larry Dupon brought a small fraction of his collection of Mac and Marantz, probably the largest in the USA. Joe Waclaw presented a variety of tube amps and speakers at great prices. Carl Lindell brought a very rare set of Rogers-Eaton amps and some unusual English speakers. The Schultheis brothers presented a pair of excellent sounding speakers of their own design. Ed Stock and Harry Pallor had a table filled with the most desirable Western Electric tubes and high precision components. Steve Puntillo displayed one of the very first German reel-to-reel tape recorders and an incredible Kohl coherer from the beginning of the 20th century. There were Heil liquid-cooled speaker towers behind James Bond's table along with professional recording gear. Victor Paulis, formerly of Victor's Stereo, brought miles of interconnect cables and it seemed like he was giving them away. Arnold Shechtman had several very clean tube amps and Mike DeBroch presented a sizable display of current gear. Charles Crittendon had a variety of bargain-basement Electrovoice speakers and a collection of audiophile records. Fred Georges projected smiles across a display of Dyna equipment and Mick Johnson had some sophisticated modifications for Revox CD players, among other things.

There were more exhibitors than I mention here. Maybe I should have carried a notebook with me; I offer my lack of journalistic experience, constant administrative duties, and the general excitement of the day as excuses for any gaps in my report.

Many individuals walked in pieces for display and sale at the Community Table. The Community Table is a concept modelled on a common feature of guitar shows. We encouraged the general public to bring equipment to sell or trade and this attraction was an very important factor in the success of the event. Some collectors and exhibitors managed to snatch some very desirable pieces at excellent prices. The Community Table was constantly busy and was received with real enthusiasm by all participants.

The variety of equipment sold, traded and displayed would satisfy a wide spectrum of collectors and audiophiles. Even the most frugal ones could find excellent buys: single Heath W5Ms went for $40, integrated tube Sherwoods could be had for $25. I saw a mint ElectroVoice 15W changing hands for $40. That made me cry - I've got one and I've been looking for a mate for over a year! There were a couple of Mac 60s, sold by two different dealers at the price of about $400 each. A Mac 275 appeared on one table for a very short moment; the price must have been excellent, it rapidly and quietly vanished. A variety of EV and JBL drivers were available well below market prices and some of them were still available at the end of the day. The same fate met a pair of shinning Jadis 80; they attracted a lot of interest but nobody with enough cash to take them home for the price of a small car.

Some large, pro-looking reel-to-reels and plenty of professional studio equipment was available and sold after long negotiation. I noticed a pretty Micro-Seiki turntable changing exhibition tables and the same amplifier displayed first at one table and a little bit later in another corner of the room with a doubled price tag!

There were plenty of parts, tubes, and transformers and a couple of amazingly young fellows rummaging through them. They were seeking contacts with other amp builders and after I saw them with a group of guys chatting away energetically, I was sure they found who they were looking for!

The combined knowledge and experience of attendees was astonishing. Ron Steinberg invited Mr. Boom of Boom, Inc., a walking history of American professional sound installation. The scrapbook and photo album he proudly displayed was unique and fascinating. It brought to life the history of the Western Electric Company's era of dominance in the commercial sound market in the 30s and 40s.

The best deal of the show? A pair of massive, only slightly rusty American Projector basic power amps, studded with fantastic transformers for *FREE*! The worst deals? There weren't any.

I know that many people attended the show without paying admission; our policy was quite lenient and we really did not care. On the basis of a completely unscientific survey, I estimated that we had over 250 people in attendance. The actual number could be higher - the crowd at peak hours was enormous for the size of the room and it seemed a lot more than 250.

Some fellows spent the whole day hanging out at the show, talking their heads off and really enjoying themselves. The energy level was unbelievable. Almost everybody asked about the next show!

My partners were great PR agents and they executed the First Chicago Classic Audio Fair to everyone's delight and satisfaction. The show just happened the way it should. As Mike Schultheis summarized it on the day after the show: "It was the best vintage audio party that ever happened." The first show did cost us a little in the final accounting but it was worth every penny and all the man-hours dedicated to organizing it.
People loved it. We did too.

The Second Vintage Audio Fair is underway as we go to press. To get on the mailing list for future shows write to Kris Wawer at 1731 Elm St., Northbrook, IL 60062. Hopefully, Kris' story will encourage you would-be audio impresarios to organize similar ground-breaking events in your area. Let us know if you decide to try.



Fixing Up Nice Old Radios
by Edward Romney
c.1990 Romney, Box 96,
Emlenton, PA 16773
No ISBN number

Ed Romney is best known as the name behind the "FIX YOUR OWN CAMERA" ads in the classified section of the bigger photography magazines. He publishes a whole series of books on the arcane and secret art of camera repair, loved by technically inclined camera buffs and cursed by "professionals"- probably as much for demystifying their black art as for any content issue. This is his first major publishing effort in electronics, the field in which he was formally trained while serving in the Army back around 1958.

This is not specifically a book on high fidelity audio. Romney starts at the beginning of electronics, going back to the first vacuum tubes and the birth of radio. He covers basic electrical and electronic theory before the transistor in a tour through the spark and crystal radio days, the first vacuum tubes, regenerative receivers, power supplies, RF amplification, and audio amplification. He then introduces superheterodyne receivers, multi grid tubes, communications receivers, old ham gear and "complex high quality radios and early hi-fi gear."

No need to ask which of these we are most interested in here, eh? The hi-fi section includes brief descriptions of early Williamson and Mc Intosh (pre MC 30) amplifiers. He touches on using Twenties radios as AM tuners as sources for hi-fi and other interesting tidbits. Also of interest are the audio sections of the Zenith Stratosphere, which uses eight 45 tubes in push pull configuration with separate woofers and tweeters fed from two different output transformers!

Romney's readable intro to tube electronics and collection of unusual circuits aside, the most interesting (or threatening, if you're an uptight liberal) thing about this book is Romney's running sociopolitical commentary. Basically, he's an old futz - one can infer that he's around 60 but his upbringing must have been strict 19th century - who rails out at the pernicious effect of "acid rock, violence, and sex" and the "ultra-liberal opinions of Dan Rather and Ted Koppel".

"The three networks are controlled," Romney reliably informs us, "by a New York elite that hates almost all that Middle America believes in...the American flag, marriage and family, law and order, and the Christian faith." If, like me, you grew up reading the American Opinion magazine-preferably with a Velvet Underground or Fugs tape running through a Twin Reverb in the background - this book will bring back memories.

So, you might ask, how good a book is this if you want to learn how to fix old radios? Not bad - as long as you understand that no book can teach you how to do *anything* - you'll have to experiment and learn to troubleshoot by doing. You CAN teach yourself - in fact, it beats paying good money to go to some bogus technical school staffed by retired Navy guys with nothing better to do - but you have to start simple. This is a good book as they go, but no one book covers everything. Get at least four or five good ones. Also keep in mind that repairing electronic stuff is different from building it and there are a lot of ace technicians who never built anything in their lives and couldn't if they wanted to.

If your only interest is hi-fi and you already have some tube theory down, I'd have to say that the $25 investment in this 180 page, GBC bound book might be best directed elsewhere. But if you need a readable introduction to vacuum tubes and some typical applications, have an interest in old radios, or, like myself, you just want to read some good old-time right wing bitching now and again, you should consider a purchase. See if you can get the local library to buy one: measured strictly on its merits as an "old radio book", it beats The Johnsons' "Guide to Old Radios" by a mile and Joe Carr's "Old Time Radios: Restoration and Repair" by at least the $10 price difference.

The Tubeskate



from the archives

Making Use of Load Lines

by Norman H. Crowhurst

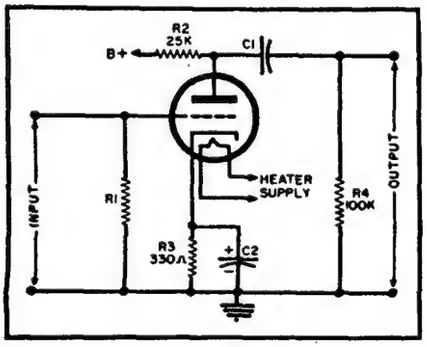
The gap between "theory" and "practice" can be bridged by using graphic tube characteristics and load lines.

Ever since the days when electronics went under the name of radio there has been a controversy between the "theory" and "practice" boys. The proponents of "theory" like to start by calculating a circuit in all its detail. After building it, they hand it over to a practical man to make it work. The practical man naturally argues that practice is of greater value because the theorists never arrange to arrive at the right answer the first time.

Often the designer who relies on theory does not take all of the factors into account. In "theory" a tube has simple characteristics which are listed in a neat little table and by using a convenient formula with algebraic symbols the gain of that tube in a certain circuit can be calculated. An amplifier designed on this basis often misses its objective in one of two ways: either it has less gain than was anticipated; or, if a margin of gain was allowed to take care of this contingency, it turns out to have considerably more gain than was required. It may also be deficient in that although it has the correct gain it will not handle the full output for which it was intended.

This sort of thing happens because the neat little table of tube characteristics does not tell the whole story. The best link between theory and practice, which enables the prospective designer of an amplifier to come fairly close to the right answer the first time, is the use of graphic tube characteristics and the drawing of load lines. To illustrate this we will take a simple voltage amplification stage, the purpose of which is to receive a specified input voltage on the grid of a tube and amplify it as much as possible at the plate, in order to drive the next stage.

Fig. 1. A simple resistance-capitance coupled stage for voltage amplification.



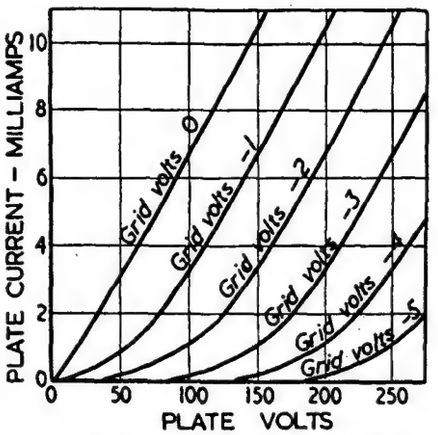


Fig. 2. Tube characteristics for use in the circuit of Fig. 1. Refer to article.

Assume that the circuit is the simple one shown in Fig. 1 and that the tube we have chosen has characteristics shown in Fig. 2. The first thing to do is to draw a load line (Fig. 3) from the "B+" voltage to be used across the tube characteristics at an angle representing the plate resistor R2.

This is done by taking the "B+" supply voltage of 250, in this case, and dividing it by the value of R2 (25,000 ohms). Thus, 250 volts divided by 25,000 ohms will give a plate current of 10 ma. The load line is then drawn between 250 volts and 10 ma.

Next we want to find what value cathode resistor (R3) is required to provide the right operating bias. This really is quite simple: we have to find a point along the load line that will be a suitable operating point to give the required degree of grid voltage swing without running into distortion and then find out what resistance in the cathode will give us the bias value corresponding to this operating point.

Suppose we know that the maximum voltage swing applied at the grid of this tube will be 1 volt, then from the tube characteristics, we will find that the best operating position is about 1 volt negative so that the swing of 1 volt alternately positive and negative from this position goes from zero to -2 volts. That this will give the minimum distortion can be seen by examining the spacing between the various curves representing different grid voltages. The spacing between the curves for zero, -1, and -2 grid volts is nearer equal along the line than any other pair of adjacent grid voltage curves. The spacing should be equal so that all of the waveform is amplified uniformly. To allow a slight margin to avoid the positive grid region which causes grid current flow, in case the voltage swings a little more than 1 volt, we will choose a bias voltage of -1.5 volts. This gives us the point B on the load line shown in Fig. 3.

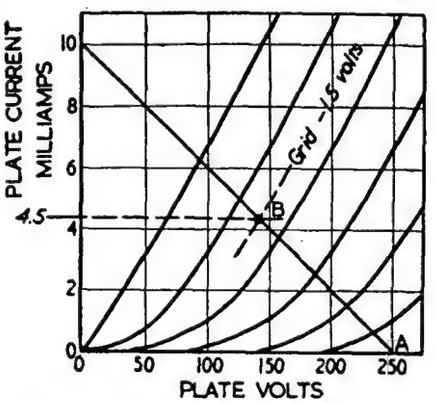


Fig. 3. First step in calculating values. The load line represents an R_2 of 25,000 ohms. The cathode bias resistor is calculated from plate current and the bias voltage operating at point B. Refer to text.

Referring to the current scale at the left-hand side of the tube characteristics, we find that point B represents a plate current of 4.5 milliamps. We now have the information necessary to calculate the value of the bias resistor R3; it must drop 1.5 volts with a plate current of 4.5 mil-

liamps; this means its resistance value must be 1.5/.0045 = 330 ohms.

Now, to work out the rest of the circuit, in order to provide a voltage for driving the next stage grid, we need a coupling capacitor C1 and a grid resistor R4. To calculate the effect of these components on the amplification of the tube we have to recognize two things that may not be obvious at first sight: first, that the coupling capacitor C1 blocks any DC potential from the grid of the next stage and, second that at audio frequencies the reactance of capacitor C1 is negligible.

This means that, as far as audio frequencies are concerned, R2 and R4 are effectively connected in parallel because at one end the reactance of C1 has negligible effect, and at the other end "B+" is connected to ground through a low reactance decoupling or smoothing capacitor. So we have to draw another load line to represent R2 and R4 in parallel.

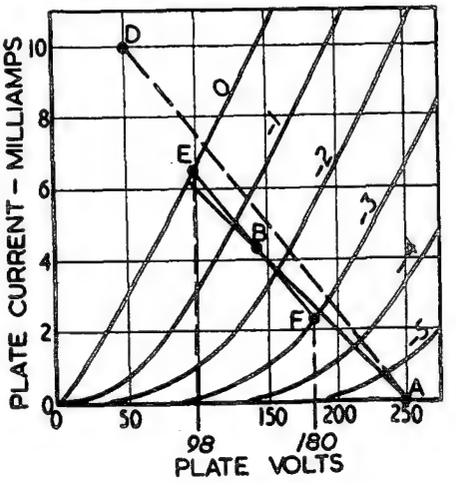
We can easily calculate the value of this load line from the formula R = (R2 + R4)/(R2 X R4). Assume for example that we choose 100,000 ohms as the value for R4. R2 has already been set at 25,000 ohms so the value of R works out to be 20,000 ohms

If R2 is actually 20,000 ohms instead of 25,000 ohms, the load line would be as shown dotted at line AD in Fig. 4. But because the DC feed to the plate of the tube is only through the 25,000 ohm resistor, the "direct current" load line is truly represented by the line AB, and the operating point has been set by choice of resistor R3 at point B. So the "dynamic load line", as it is called, or the load line for amplifying purposes is represented by drawing a line having the same slope as AD, but passing through point B. This is very simple to construct, by drawing a line parallel to AD through the point B. This line is shown as EF.

EF is shown connected between the grid voltage curves for zero and 3 volts, because the actual swing which will be employed for amplification purposes will not be greater than this -- actually a little less.

Now we can see how much amplification the stage will give. Point E on the zero grid voltage curve represents a plate voltage of about 98 volts. Point F, on the -3

Fig. 4. Remaining steps in calculating performance of stage. AB is the direct-current load line, obtained as shown in Fig. 3. EF is the dynamic load line, taking into account the effect of R_4 through C_1.



grid voltage curve, represents a plate voltage of about 180 volts. So the grid voltage variation of three volts between zero and -3 will give a plate voltage variation of 82 volts -- from 98 to 180. These are convenient values to read on the graph but other voltages will run proportionally, so dividing one by the other, this means that a grid voltage swing of 1 volt will give a plate voltage swing of 82 divided by 3 = 27.3 volts. Otherwise expressed, this stage will show a gain of about 27.

This method of working out the performance of a tube comes a lot nearer to the practical results than calculation using the algebra given in textbooks and the tabulated tube constants given in a tube manual. It will also show without any doubt whether the tube is capable of handling the volume level intended at the particular point in the amplifier without overloading, a point which use of the tabulated data in a tube manual may overlook.

All that is left in completing the stage is to determine the value of the cathode bypass capacitor C2. By good engineering standards the reactance of C2 at the lowest frequency to be amplified by the stage should be 10% or less of the cathode resistor R3. In this case, the reactance of C2 at, say 50 cycles, should be 33 ohms at most. This would work out as 100 mfd.

Pursuing the case we have just considered a little further, we know that full volume will represent 1 volt on the grid of this tube and that this 1 volt on the grid will produce about 27 volts on the plate. From there we can consider the next stage with the characteristics of a suitable tube, knowing that we will get up to 27 volts swing on its grid.

In this discussion, we have been working forward, i.e. we started with 1 volt input and worked our levels forward toward the output. In practice, it is often better to work backward from output to input. We know first what voltage we need at the grid of the output tubes. From there we work backwards to find what tube and what resistance values we can use to get this voltage to drive the output tubes. We then find what voltage this tube needs to swing its grid to give the required plate swing. Then we move back to an earlier stage to find how we can get enough gain from the available input voltage.

Irrespective of whether we work backwards or forwards, this discussion has shown how valuable a load line can be in determining a circuit for a simple tube. We have kept the discussion to a consideration of voltages, because the kind of stage we have talked about has been the one known as a *voltage amplifier.*

This article first appeared in the November 1955 issue of "Radio and Television News". Reprinted by permission of Gernsback Press. Readers' suggestions for future archives reprints are welcome.

Mullard

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TRIODE CONNECTED PENTODES

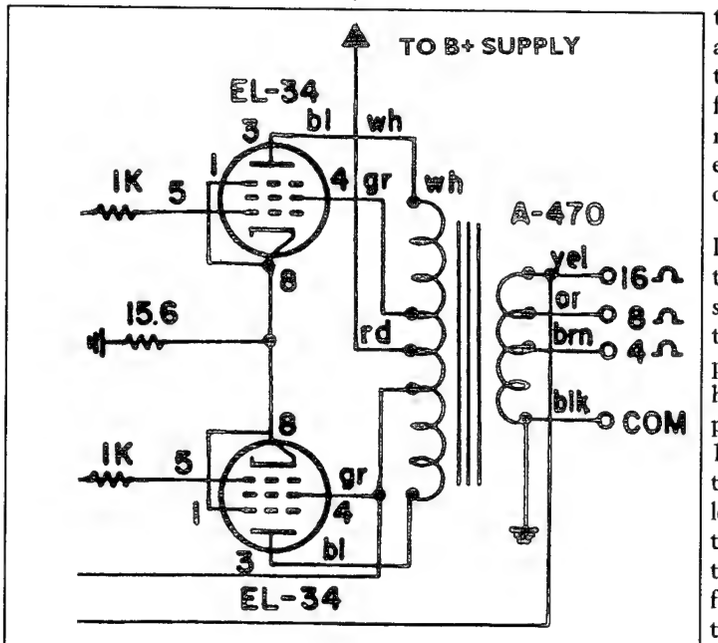
HERB REICHERT, EDDY ELECTRIC INC.

Back in 1955, some of the big audio "issues" were: Which provides higher fidelity, triodes or pentodes? Feedback or no feedback? Active or passive? Solid core or stranded wire? Does this all sound familiar?

It was in this climate that D.T. Williamson's amp arrived. The old guard believed that there was no substitute for 2A3s push-pull. But the hot issue in the audio mags was high power. High power back then was only 20-30 watts, but it was thought that the extra headroom contributed to a sense of effortlessness. The Williamson amp tried to be both. Triode connected KT-66s gave this amp the low-distortion loadline of triodes with some of the gain and efficiency of beam power tubes. This circuit and its siblings became the most popular tube amps of all time. It also created the most popular tube modification of all time: triode connecting multigrid power output tubes.

It looks like we are at the threshold of a major triode revival and I suspect that the triode wiring of thousands of Dyna ST-70s assisted this trend. The first step for many towards pure triodes is to connect the screen grids to the plates of their present amp's output tubes and listen for a while...just to see what it sounds like and find out if there is enough power left to drive their present speakers. But. . . are we really listening to just a triode version of our present amp or some new hybrid?

When we connect the screen grid to the plate (usually with a 100 ohm, 1/2 watt resistor to suppress RFI) we really do get a new tube. A funny triode with a bunch of wires in the electron path. Some believe these leftover wires cause problems but we won't go into that here. This new tube has a more linear loadline, lower plate resistance, lower gain, and higher transconductance.



For triode connection of this "typical EL-34 amp" disconnect both screen taps (gr) and connect plate (3) and screen (4) of each output tube through a 100 ohm resistor

SPECIFICATION	PENTODE	TRIODE CONNECTED
Open loop gain	175 (44dB)	50 (34dB)
Closed loop gain	20 (26dB)	15.6 (23dB)
Feedback	18.8 dB	10 dB
Distortion (TH+IM)	1% @ 30 watts	2.7% @ 15 watts
Feedback factor (1-BM)	8.7	3.2
Sensitivity	1.3v for 30 watts	1.6v for 15 watts

TABLE I:
EFFECT OF TRIODE CONNECTION OF TYPICAL EL34

This would be fine, but our present amp was not designed for this tube. Changing these characteristics of the output stage changes the electrical structure of the whole amp. These changes are significant and are more than likely what we hear when listening to our new amp. Let's look at some 'before and after' amp specs (Table 1).

The numbers are approximate, but they illustrate exactly what is happening with a typical EL-34 amp. When we connect a tube in triode, we typically reduce the distortion of that stage by one-half. However, designers choose tubes primarily for their gain characteristics. In this case, the gain of the new tube is less than one tenth of the gain of the old tube. This changes the overall gain structure of the amp (see G. Rankin's article) and most importantly, it modifies the "gain reduction factor" due to feedback. Simply stated, feedback reduces distortion by a factor equal to the inverse of the gain reduction factor. Real simple? No?

Let me try again. When we switch to triode we reduce the gain and sensitivity of the amp causing us to use a bigger signal from our preamp. So why do many find happiness in triode connected pentodes? I suspect it's because a 10dB reduction in feedback makes the amp sound more "relaxed" and less bright. Feedback can thin out the sound, so this kind of reduction can give the new amp more fullness of presentation. Due to the above considerations, bandwidth and damping factor are reduced slightly, giving the amp a softer feel.

Output power is cut in half but many have noted that the apparent power in triode connected amps seems increased. This is because the amp now goes into and out of clipping more gracefully. Less sensitivity and less feedback allows us to drive these amps harder with less signs of distress. The more than doubled distortion shows up mostly as noise or lack of transparency. This can be corrected but would require a redesign of the amp.

Is it then a wise idea to convert? Yes and no. For many systems, the result of this change would be an increased enjoyment of recorded material and this is what we are looking for. It is certainly an easily reversible mod in any event. In a purist system, however, it would represent a compromise and the listener is advised to seek out a pure triode amp.

Perhaps there really is no substitute for 2A3s push-pull?



W.A.F.

by Joyce

FEAR OF FRYING:

Or How I Learned to Stop Worrying and Love My Home Audio System

Despite the fact that I've been married for years to an *audio geek extraordinaire*; despite the fact that back in college I owned the mini-component audio system that was the envy of the entire fourth floor of my dorm; despite the fact that I have artfully wielded a soldering iron (okay, so his arm *was* in a cast, and mine *was* twisted behind my back, no matter), I still find that nobody takes me seriously as an accomplished, dues paid-in-full, *audio aficionada*.

I really resent this. All I have to do is walk into a room full of "audiophiles" and the conversation goes something like this, "Yeah, this 6J5 output to primary voltage resistance is very *musical*. Oh, hi Joyce, bake anything interesting lately? Great. Like I was saying, try an unfilamented 90LX cap to ground next time and blah, blah..." Okay, so maybe electronics manuals *aren't* my favorite bedtime reading and maybe I *was* diagnosed with math anxiety at the tender age of eight. None of this means I don't like *music*, beautiful, tuneful MUSIC.

Furthermore, and this I believe is the clincher, *I KNOW HOW TO TURN ON MY HOME AUDIO SYSTEM!* Hey, no laughing! Seriously, we're talking *delicate* precision work, demanding *utmost* concentration and skill. Why, if it weren't for the prohibitive cost of the lawsuit that would surely follow, I'd even suggest, "go ahead and try it for yourself." Hah!

I will admit that it took some time to get the exact procedure down. Presently I have an advantage in that we've had the *same system* hooked up now for *3 weeks straight!* Amazing! Used to be I'd wake up in the morning, go into the living room and not recognize *one single* component. It was as if the Munchkins had switched everything overnight, plus they kept on digging deeper and deeper into the junker pile. But now, like I've said, I can pretty much tell what's what, and this is how it works:

The first step, after identifying your components, is to get the preamp going. This can be a little confusing, especially since our current system's preamp comes in *two* pieces and is *much bigger* than any amp I've ever seen. So I've devised this little jingle to remind me, "Two boxes, pre-amp; Four tubes, amp" which I can kind of repeat to myself as I go along. If I hit the right switch on the preamp (naturally none of the switches are labeled) a little yellow light starts flashing. Once the little yellow light *stops* flashing I know its time to get the amp (second part of the jingle) going.

This next part is very, very tricky. The homebrew amp we're using has *no controls* whatsoever, let alone an ON/OFF switch. What's more, I was recently given the following warning: "You see this thing here; it's our new amp. Don't ever, never, *never*, touch this bottom plate because its not grounded. And Honey, I know how clumsy you can be, so please don't move this amp when you're vacuuming, even if it is turned *off*, because I'm trying out different capacitors and this one here is just hangin' on by one little screw and these bad boys *really* store power, okay Hon?" *You bet!*

So, after always double-checking to make sure I'm wearing rubber soled shoes, my next step is to just plug the sucker in. A soft hum and the gentle tinkle of glass tubes warming up means I've managed to turn on the amp (step 2). A foghorn-like crescendo drives me to momentarily evacuate the room and try step 2 again as soon as I can force myself to reenter.

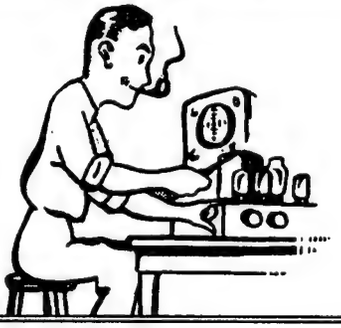
If all has gone well so far and those tubes start glowing merrily, I now proceed to select the next component. So what will it be: CD, record or tape? Well, since no CD player or disc, dead or alive, has ever made it into *this* house, and my own beloved tape recorder was long ago traded in for who only knows what, how about some good ol' vinyl? Analog forever! (I guess.)

Next comes the most challenging step. You see, the turntable hooked up today comes complete with its own *life support system*. Designed to float on a luxurious cushion of air, this marvel of modern audio engineering has its own personal oxygen pump (so noisy it had to be sequestered in the coat-closet) together with an immense coil of hospital-grade oxygen tubing. The tricky part is to ensure the turntable a constant, uninterrupted supply of pumped air, or else it will go into immediate audiocardiac arrest. After tenderly uncoiling 100 feet of oxygen tubing and checking for free passage of air, I am ready to flip the big switch.

Only one thing left to be done. Yes! The alligator clip holding the monstrous speaker cable to the absolutely gargantuan, singular speaker (its mate was too large to fit in the same room) is still in place! This aspect of turning on the system was a hard learned lesson; time and again I completed all steps toward the achievement of musical bliss only to be thwarted by such a small thing as a shorted alligator clip, resulting in a truly earsplitting whine. This time all goes well. I now give myself the all clear sign and, millimeter by millimeter, I gently lower the cartridge onto the spinning vinyl.

Now I ask you, *how could you possibly doubt my love of audio?*

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SOUND PRACTICES

A JOURNAL OF AUDIO TECHNOLOGY EARLY 1993 FIVE DOLLARS



Audiophile Attitudes

Vol 1: #3

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More than meets the EYE

In principle, everybody seems to agree that live music should be the reference by which reproduction is judged. However, one of the great dilemmas which confronts the audiophile is that you get so good at listening, so perceptive of nuance and aware of the characteristics of the media, that you can't easily be fooled into believing there is live music in your room. Paradoxically, the better we learn to hear the farther we stray from oneness with "the music."

Our real break with the audio past is in the ways we listen, not in the new technologies we use. Through methodical self-reflection and meticulous training, the modern audiophile has learned to listen in new ways and for new things. In the 20 or 30 years we have been developing these novel uses for our ears, we have gotten very good at listening analytically and describing what we hear in a bizarre and specialized jargon which only makes sense to those of us in the club.

Because of the studious disbelief the audiophile brings to his or her armchair perception laboratory, critically listening to reproducing systems and critically listening to music have become two very different experiences with divergent criteria, procedures, and assumptions. In pursuing our analytical agenda, we impose templates on the listening experience which are alien to the experience of live music.

Audiophile phenomena irrelevant to live music are central in the evaluative frameworks we use to assess our systems' performance. Even the most crazed audiophile wouldn't describe an actual live performance as "musical." Did anyone ever say "Yeah, that concert had a great soundstage"? When we talk about music, even reproduced music, we talk about different things in different language than we use to assess reproduction. Relative positioning of sounds, image size, and intra-ensemble "air" are not a big part of what gives musical events meaning.

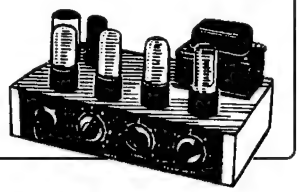
So when we praise our systems excellence at reproduction, we do so in language that highlights precisely those aspects where audio systems fail to pass for the real thing. In both appreciation and criticism, we focus on artifacts of reproduction rather than the musical or performative content of the reproduced material. With "real" music, many of the things we're searching for in our systems either don't matter or are taken for granted. It is only when we suspend "critical" listening that we can really lose ourselves in music. Music is about how well sounds blend together. Too often, we well-schooled audiophiles only focus on how well sounds can be isolated and differentiated. Strange business.

Since it's so *important*, some designers have optimized imaging capabilities to the detriment of "musicality"— a hotter buzz word than "imaging" these days and one worthy of serious discussion. Some music lovers feel that there's too little musicality in many 1993 state-of-the-art systems. Are we finally ready to admit it?

The direction finding/localization function of hearing is not an important component of my enjoyment of most music. Pinpointing images with our ears creates an unnatural division of sensory labor. Ears should be listening to music not localizing sounds. Ears aren't even that good at direction finding—that's why blind people carry sticks. At performances, I can use my eyes to tell where the performers are located, if I care. Good music often makes me want to close my eyes. An even more unnatural act is listening for the many ways in which space is distorted in reproduction— and it is always GROSSLY distorted. Usually not even close.

Visual perception is not an adequate model for musical perception. We don't really go to "see" a concert. Perhaps, all those allusions to photography and optics (focus, transparency, veiling, etc.) provided a convenient metaphorical framework to get a serious reassessment of reproduction moving, but they don't get us too far in our "search for musical ecstasy." Music is more than meets the eye.

New Products



VINTAGE HI-FI SPOTTERS GUIDE: VOLUME 2
Like Volume 1, this book consists of about 90 pages of reproductions of ads and manufacturer's literature on audio electronics and speakers from 1929-1963. Featured equipment ranges from the familiar (Mac, Heath, EICO, etc.) to the rather obscure—ever see a Brainard A-200 binaural amplifier? Compiled by collector Charles Kittleson, who provides some intro level historical commentary, tech tips, and collecting hints for the uninitiated. Available from ***Antique Electronic Supply*** or Kittleson himself. $14.95 + S&H.

CHARLES KITTLESON
PO BOX 691
BELMONT, CA 94002

1993 WELBORNE LABS CATALOG
The new 175 page, spiral bound ***Welborne Labs*** reference catalog features an interesting selection of kits and quality parts for vacuum tube and silicon enthusiasts alike. Ron Welborne is gracious enough to provide complete schematics and parts lists for all of the mods and kits he offers, including some refined mu stage Dynaco mods by Alan Kimmel. Also included are updated classic Acrosound designs and essays by Roger Modjeski on tube matching and why the sound changes when you change tubes. $10 US, $12 International.

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POWER SUPPLY FOR GARRARD/THORENS
Vintage gear expert Haden Boardman of ***Audio Classics, UK*** is offering a limited edition PSU which optimizes performance of the classic Garrard 301/401 and Thorens TD-124 tables. This novel unit consists of an oscillator driven 20 watt transistor amplifier transformer coupled to the turntable motor, providing precise speed regulation. Where were you thirty years ago?

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WIGAN, LANCASHIRE WN2 3AF, UK
VOICE 0942 57525 FAX 0942 525861

TUBE SUBSTITUTION HANDBOOK
Prompt, a division of Howard Sams bring us this latter day tube substitution guide compiled by William Smith and Barry Buchanan. Remarkably comprehensive, it contains many industrial and European tubes of interest to the audio experimenter and many you couldn't care less about. Basing diagrams are provided for all listed tubes. Unfortunately the authors have not discovered any previously unrecognized cheap substitutes for the 300B. $16.95 from ***Antique Electronic Supply*** or ***Old Colony Sound Lab.***

SINGLE ENDED 845 AMPLIFIER
Bel Canto Design, Ltd. is introducing a single-ended triode monoblock amplifier, called the ***ORFEO***, which uses the 845 triode. These class A amplifiers deliver 30 watts with a 3 dB bandwidth of 4 Hz to 40 kHz, less than 0.3 dB down at 10 Hz and 20 kHz. Distortion at 1 watt is less than 0.1%. The ***Orfeo's*** hand wound US made transformer provides 4 and 8 ohm secondary taps. This amplifier has two triode amplifier stages with the input stage using 12AX7s in a modified SRPP configuration for a low output impedance. No local or loop feedback is employed. The ***Orfeo*** is a third generation design with dual inductor input power supply filters, a balanced inductor input regulator supply for the 845 filament, polypropylene filter caps, and an input transformer which allows single ended or balanced inputs with isolated grounding to avoid system ground loops.

The tubes and electronics are mounted on a floating subchassis, much like an analog turntable, to prevent microphonics from affecting the output. This is a highly refined and powerful implementation of the single ended design concept. Other ***Bel Canto Design*** products include a high quality D/A converter, solid state and tube preamplifiers, and a solid state amplifier borrowing many single ended design concepts in an unusual circuit architecture. Information on these products can be obtained by calling John Stronczer at 616-668-5734 or Larry Harvey at 612-474-3718.

HI-FI WORLD
The April issue of this UK magazine is worth tracking down. It features a review of the Garrard 401 turntable, restoration hints for this classic table, and a short history of the Garrard company. A 30-page DIY supplement provides details on the construction of a modern version of the classic Mullard 5-20 P-P El 34 amplifier, construction hints for the novice, and a primer which would be useful to the first time constructor. The project is presented in terms of the personal experiences of a few staffers who built this kit amp as a first project. Their excitement and sense of discovery is inspiring. Remember the first time you hooked up an electrolytic cap backwards?

Previous issues contained reviews of UK single ended triode amps and glimpses of exotic British vintage gear, including the Pye Mozart single EL-34 stereo amp. ***Hi-Fi World*** casts a wide net over the sea of audio practice and comes up with a highly refreshing grassroots orientation and a personal feel that is largely absent in the mainstream press in this country. Available at major newsstands or at the US/Canada rate of 52 Pounds yearly.

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SIREN SONG:

A PHONO PREAMPLIFIER FOR HEDONISTS

BY J.C. MORRISON

In philosophy, as in life generally,
it all comes down to what you like...

In his blueprint for the ideal state, Socrates advocated strict censorship of music, lest his citizens be tempted by "weak or voluptuous airs" and thereby be led to indulge in demoralizing emotions (Plato, *The Republic*, bk. III). The same principle is often invoked by the high-end audio press to legitimate the value of 'recommended components' or 'audiophile' recordings. Above all, these things must embody a certain "neutrality" if they are to be considered worthwhile.

For me, the zeal with which this inquisition is carried out recalls all the pomp and celebration of Dan Quayle's family values debate. Thank goodness someone keeps an eye on things!!! It seems that Puritan Hi-Fi is in. . .Bacchus beware!

Could it be that at times people vehemently reject a position, not because it *doesn't* recommend itself, but because it *does*, and because its acceptance threatens deeply held values in some important way?

So what about this siren's song, this un-neutral spell chant, this voodoo rhythm? What lustful impulses, whose earthy terrors, require such righteous and diligent policing?

A MODEST PROPOSAL

This article is dedicated to an openly and proudly libertine phono-preamp. You can build it yourself, or have me or your favorite someone do it for you. Its primary purpose is to play Billie Holiday just as 'enthusiastically' as it will Shaded Dogs or Sex Pistols. In other words, it's an instrument for those of you who like to play records. This design, which we'll call the "Siren Song," is specifically arranged for moving magnet type cartridges. Every effort has been taken to ensure that the performance of this device will be sentimental, agitated, maudlin, tender, but under no circumstances "neutral." This is not to say that it is unsophisticated or sloppy, rather that it tries, above all, to lure the joy out of your records, not sterilize them.

Perhaps a quick word about LP transducers is in order. . . moving magnet (MM) cartridges favor the midrange over the frequency extremes: the bottom is the loser and the top can be crunchy (Shure V15-VMR) or somewhat soft and rolled off (Grado Signature, Promethian). However, MM has a richer and more informational middle than moving coils. Some might say that it's *too* good. This quality, plus the higher output voltage makes MM more suitable for designer debauchery. There are wonderful MCs and tricks for making them sing, but that's another story for another time.

THE CHALLENGE

To my mind, nothing seems more impossible than a preamp, especially one which would satisfy the truly hedonistic listener. LP records contain an amazing quantity of subtle timbral information. This same information is subject to bombastic dynamic shifts, both upwards and toward silence. CD arguably has better dynamic range, from silent to earthshaking, but it doesn't compare on the informational scale. LP portrays both gracefully and with an even-handed balance. This has a lot to do with the lasting appeal and social durability of the LP (...not to mention real liner notes!).

However, dragging both extremes out of the grooves is a real challenge. The sensitivity necessary to hang on to the small, gentle stuff typically causes the preamp to jump in an overstated fashion when the thrashing starts. Likewise, the preamp that clamps on to those "roller coaster" records invariably damps away the little colors and edges one prays for. Compromise is *always* the case with preamps.

For clarity's sake, let me rephrase that part. . . highly sensitive preamps often exaggerate shifts in timbre and intensity in such ways that they "glare" (☹), "sing" (♫), or sound "better than life" (☺). Well damped preamps give us a tight, controlled, and punchy performance but often sound thin and generalized. The art in preamp design lies in understanding the line between these things. The line itself is unreachable because that line is REALITY—preamps are about illusion, not reality.

The criteria we use in our assessment of the hi-fi experience are rooted not in some 'pure objective measure of realness' but in an utterly contingent subjective value system. Reproduced sound is *symbolic of* not *equal to* "reality" (whatever that actually is. . .) The play of symbols and the pleasure of that activity is an aesthetic and moral activity. Without exception, design and evaluation of these reproducers is tied to the values we bring to the experience of sound reproduction. What is to be considered like "real" is subject to interpretation, regardless of what one would say or believe to the contrary.

Unfortunately for us hedonists, at present our musical ethos is under the skillful management of a journalistic elite whose ancestors came from cold northern lands, bringing with them a strict Protestant musical ethic. The Puritans of Hi-Fi preach neutrality, abstinence, self-denial, and economic penitence. The commercial world obeys, promotes, and elaborates on the gospel. We all know what side of the line they stand on: musical austerity.

These Audio Puritans are a smart and highly talented bunch. They are very good at what they do, and they present a coherent, logically argued front. Many converts have joined the puritanical fold. Their ministry is so pervasive that people look at you funny when you propose an alternative vision of the goals of reproduction. Come on, guys, loosen up a bit—take off your bow ties.

Having said this, a few other difficulties crop up that can really interfere with our lusty quest for harmonic narcosis. First off, amplifying devices are always imperfect: they blunt, ring, overshoot, and otherwise deviate from input signals.

Another problem is that a sensitive amp is sensitive to everything, not only the signals originating from the cartridge. Output signals persist which are completely unrelated and irrelevant to the input. In many cases, these undesired signals will trace their roots back to the AC line. Aside from the fact that AC is by nature a troublesome cause of hum in low level circuits, many forms of noise can be coupled into our sonic chain capacitively or inductively through the power line. Other interference signals also work their way in, the most important of which have thermal, mechanical, acoustic, or electromagnetic origins. The preamp exists in a complex and challenging physical and electronic environment which threatens ideal operation in many subtle ways.

The difficulty can be summarized in this way: an extremely high voltage sensitivity is required to portray the more subtle information the transducer supplies. But, high sensitivity leaves the preamp vulnerable to a wide array of interference signals and environmental influences.

Sensitivity in tubes is a function of transconductance. This is the measure of the control grid's influence on the current passing through the tube. A tube with a large transconductance will respond to extraordinarily small changes of grid voltage. This is why the 6DJ8 has been used in so many modern designs: it is actually ten times more sensitive than a 12AX7. The gain in a high transconductance tube is much more independent of changes in current. The gain in a 12AX7 can change 20% as a result of a similar change in plate current or load resistance.

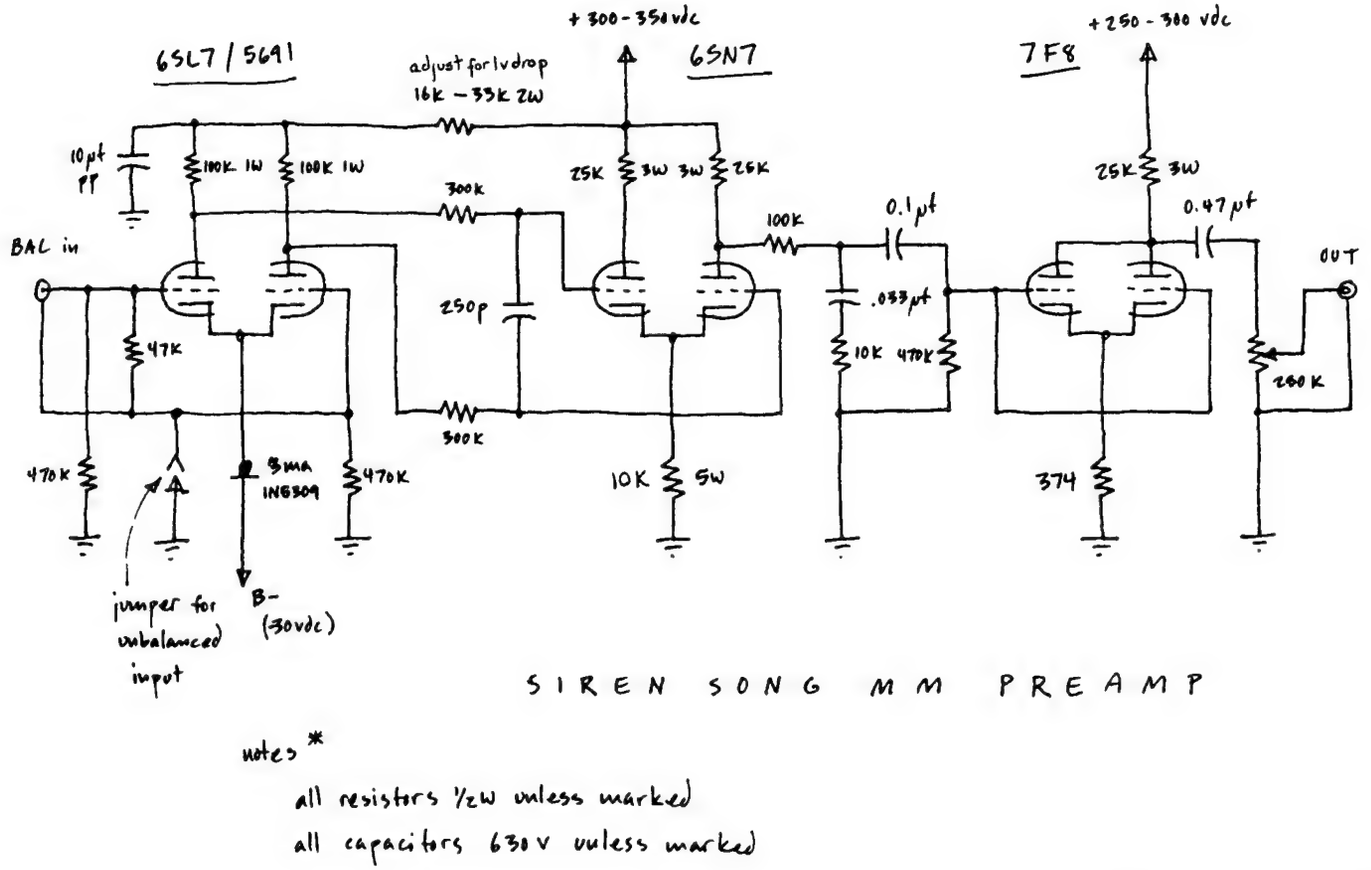
Sensitivity can be considered as the *susceptibility* of an amplifier stage to its input. The responsiveness of the first stage establishes the ultimate level of information resolution any given amp can maintain. In the low level signal environment, subtle but sophisticated mid and high frequency information will be glossed over unless great care is taken by the designer. High gain up front is essential in getting the signal into a more forgiving "size," but the overall distribution of gain and sensitivity must be cleverly managed if great performance is to be achieved. Too much gain and you get intrusive noise; too little and you get sonic mud. The first stage is the arbiter of signal quality and subtlety for the entire system. If it isn't right at the start, it can never be "fixed."

Negative feedback is the traditional fix-all for many of the problems which beset amplification devices. Feedback can also easily provide the damping and bandwidth necessary to cope with any gross dynamic quantity and many of the challenges of interfacing the device with its environment, at least on paper. Unfortunately, it usually spells death for delicacy and ambience. Recombination of unrelated signals is the ultimate blunting. Period. And one finds that, in practice, feedback provides only limited benefits as far as keeping interference signals under control (think of the PAS, Paragon, and Marantz 7C...).

A feedback amplifier is, by definition, *less sensitive* than the same circuit minus feedback. The amplification of feedback amps cannot be increased without limits to make up for lost sensitivity because at some point oscillation will unavoidably occur. This restriction is not present in an amplifier without feedback, although unwanted feedback and oscillation can sneak into the circuit anyway, and they often do.

So, while few makers of commercial audio equipment will admit it, designing a preamp is a thankless task and it always involves making some hard choices. Starting with a very small signal, we need 40 to 70 dBs of musical gain with imperceptibly low noise and distortion plus equalization covering the entire audible range. Yeah, right! Not as easy as it sounds.

Keep in mind that taking a product to market is no simple undertaking. In their quest for predictability and standardization on the assembly line, manufacturers face a set of special challenges that the hedonistic experimenter can happily sidestep. And many of the tactics on which the manufacturer relies are best avoided by the hobbyist who is interested in producing a one off, really tuned up unit.



For standardization and availability on demand, commercial makers must limit themselves to parts in current production, whether local, Chinese, or Bosnian/Hercegovinian. There are lots of top flight parts (most of them) which you can't go out and buy with 1993 date codes. The scavenger/recycler has an important advantage. If you're only building one or a few units, there is a vast range of prime quality NOS and surplus materials available at reasonable prices.

Overall, there are a number of concerns that the manufacturer must juggle which the adventurous home constructor can play with or abandon as they suit his/her goals. For example, conventional manufacturing practice almost always opts for: 1) ease and economy of manufacture, 2) standardization among samples, 3) adherence to the dominant, strict Calvinist musical ethic, and 4) "rock and roll" damping. All of these goals are attained in part through liberal application of feedback.

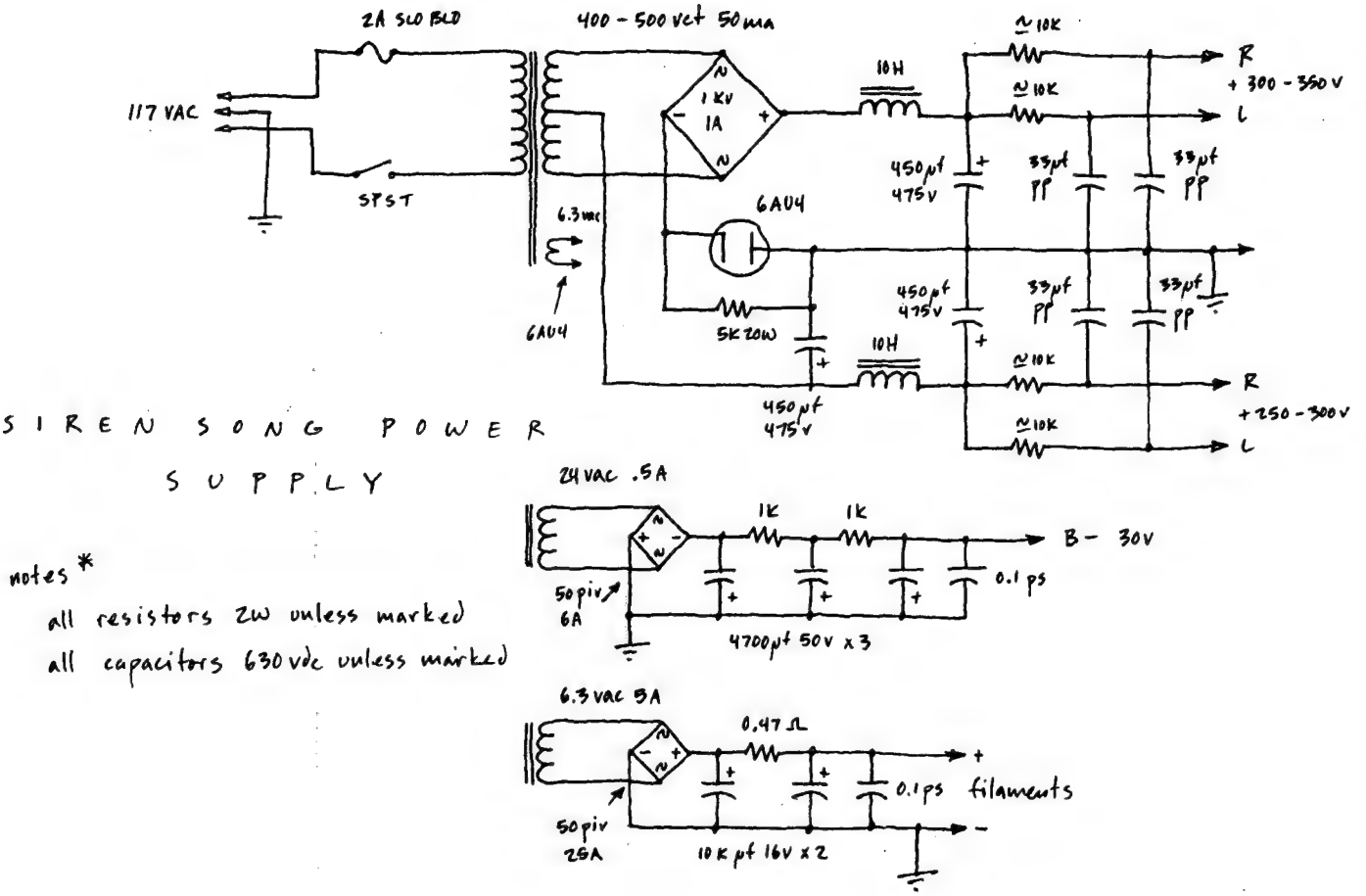
So, big league feedback is an invaluable tool for the manufacturer. It improves signal/noise ratio, bandwidth, and minimizes the effects of component variation. BUT, let us remember that there is NO free sonic lunch. Injudicious use of feedback is how all that "neutrality" comes about. The neutral (i.e., *neutered)* preamp can give a great impression of 'detail' (a category totally up for grabs...) but, nearly always sounds generalized and electronic anyway. The time domain problems of feedback have been mentioned elsewhere and these mutations bear heavily on the reproduction of naturalistic sound. Let's start over with a totally different approach based on a different set of priorities and strategies.

STRATEGIES FOR SONIC REBIRTH

First, we want high voltage sensitivity. The sensitivity of your *entire* audio chain must be increased (preamp and speakers first). That's right, just rip all the guts out of your Krell, Spectral, Mac C-22, or Marantz 7C. Save the mains transformer and the on/off switch. The chassis is reusable.

Second, if we must err, let's err in the direction of *joy and delight*. As difficult and unsettling as it may seem, you've simply got to expel those tweedy ministers of audio penitence and sonic self-denial from your listening room and your life. Let there be Audio Galvanism, not Sonic Calvinism. Base metals into gold, wine from water—that's what hi-fi ought to be! No way you're gonna get that alchemistic pagan vision from the respectable elders of the staunch conservative high end press. Expect to get kicked out of "proper" audiophile afternoon tea parties. No loss.

Next, line up all your tricks for some carefully considered selection and matching of circuits, tubes, and materials. You will be dealing with a narrow window of opportunity which can elude your efforts to identify and navigate. It can take a while before you come up with something that breaks on through to the other side. (Reread Kondo-san's article from SP #2 for insight and inspiration).

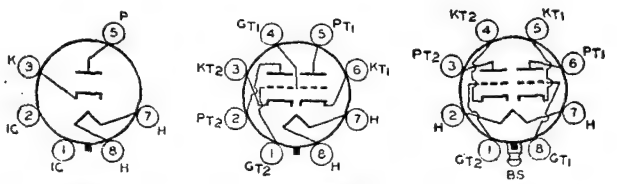


Last, and most important, invite your friends regularly for records, coffee, and eats and observe them closely for behavior which will validate your efforts, like expressions of bliss and uncontrolled foot tapping. This will ease your mind if you are still working to overcome high-end jingoism and fashion slavery.

DESIGN AND REALIZATION

The phono stage is shown in fig. 1. It is perfect for use with your line stage or it can easily drive most power amps as a stand alone unit. Output impedance is in the 5-7K range. The first two stages are balanced differential amplifiers, not push-pull stages. There are Epicurean reasons for this choice.

The effect of changes in the supply voltage is very large with a single ended stage. "DEbb" corresponds with "DEg = -DEbb/GmRl." Even when GmRl has a relatively large value (say 100), a change on the order of 0.1V corresponds to an equivalent "input" signal of a few tenths of a millivolt. This spells trouble in a high sensitivity single ended voltage amp stage.



Personally, I despise the effect voltage regulators have on tube preamps. The bass gets all big and amazing alright but what about the rest of the music? Perhaps it's a question of poor design or implementation in the mass-market stuff, but regulated preamps always sound bleached out and barren to me. Given the high power supply stability requirement for low level single-ended triode stages discussed above, and the musically detrimental effects of regulation which can give us this stability, it is almost mandatory to make the first stage of a sensitive preamp a difference amplifier.

Given the relaxed PS demands of the diff-amp, we can employ a nice choke input supply with a clear conscience. Choke input supplies provide excellent regulation and when used with good quality poly or paper/oil caps you can fully expect lovely results. For economy, electrolytics can be used in the first stage of the filter followed by "fast" caps in the second stage. I used a 6AU4 as a slow turn on device as shown in the PS schematic.

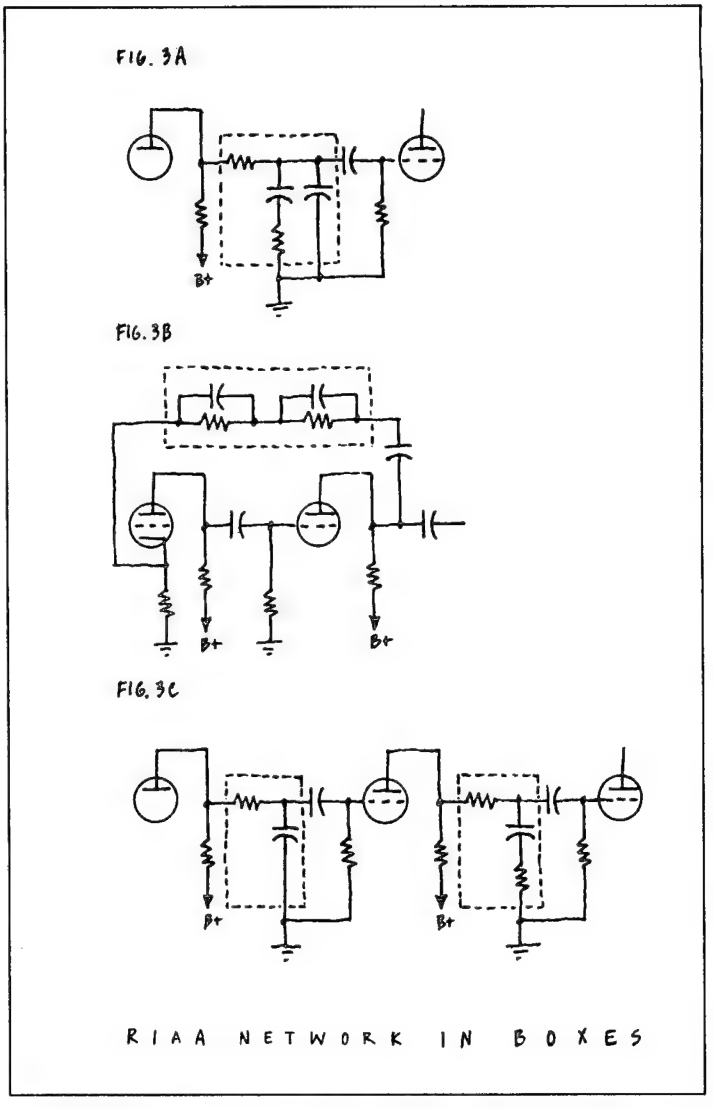
A differential amplifier can be imagined as a single-ended stage with its cathode decoupled by the low internal resistance of the cathode of a second tube, rather than by the low impedance of a capacitor. This decoupling is good all the way to DC, unlike a capacitor. While the decoupling tube operates in parallel 180 degrees out of phase, its balancing act doesn't hinder the lead tube: it is totally decoupled.

This arrangement has many applications and much to recommend it. You don't see it much because it's expensive compared to a single-ended preamp with feedback. Cascading differential stages provides the best common-mode rejection (noise rejection) of any circuit and absolutely no feedback is required to get it. This quality is preserved even if the signal is extracted from one side only several stages down the line (anywhere after the second cascade stage).

The input to this preamp is balanced. You will have to make up a phono cable with an XLR or similar three terminal connector if you want to enjoy the complete absence of hum a balanced phono line provides. For use with a standard RCA cable just connect the unbalancing jumper as shown in the schematic. The preamp is still extremely quiet when operated in the unbalanced input mode. In this preamp, the RIAA equalization is achieved with two simple but separate RC filters, each driven by a differential stage. My experiences with the other methods, feedback EQ and the popular combined passive network, have not really moved the earth beneath my feet.

If you examine fig. 3, you will find three different RIAA circuits; the first two are extremely common and well known. In fig. 3a, both the high and low turnover filters are cascaded together to make the popular combined passive network. My objection to this approach comes from the direct experience of trying to make it work. Complex networks such as these are hard to drive—just think of a power amp struggling with a fourth order crossover. The more reactive, or should we say, *interactive*, a network is, the more likely it will sound like a pair of typical modern multi-way speakers: dumpy.

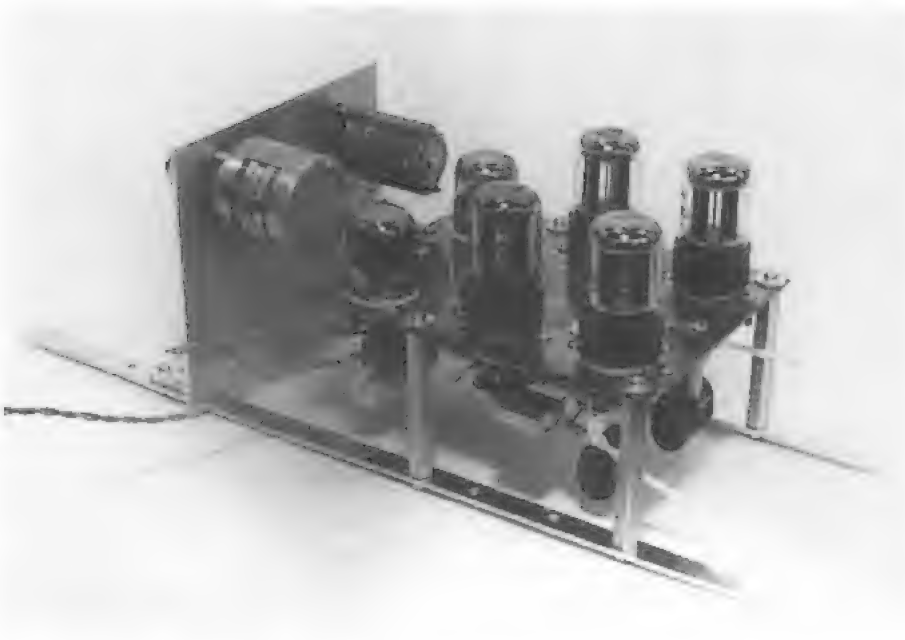
In figure 3b, you will find the popular feedback EQ circuit. Feedback EQ varies with the gain of the tubes employed. Deviation of 5 or 10% is commonplace, even with tubes from the same maker. This is in addition to the sonic difficulties associated with the use of feedback generally.



Split RIAA reduces network parts to the minimum number. The sound is relaxed and leaves space for big delights. The downside is that the loss introduced by the two filters is greater than that of the combined network. You will need more gain with this arrangement.

A careful examination will disclose that the signal sees a very simple path in this preamp. Three tubes, two caps, and three resistors including the volume control—no feedback at all. Take a close look at any popular collectible or currently fashionable preamp, tube or transistor. You are likely to be shocked by the quantity of devices you find in the signal path.

I have tried many, many types of preamp circuits: SRPP, mu followers, cascaded direct-coupled plate loaded/cathode followers, etc., in both self bias and fixed bias arrangements. They all have their merits, but this is the best sounding approach overall I've heard so far. The simplicity and freshness of plate loaded triodes with the symmetry of balanced circuits make a great combination.



Audio section mounted in test jig

As far as tubes go, it's hard to go wrong with some of the classic octal dual triodes. I like nearly all 6SL7s (or 5691s). Some 6SN7s can be a bit on the cool side. But the 6SN7 is one of the most linear amplifiers ever manufactured. Also, highly worthy of consideration is the 7F8, a loktal radio tube common at hamfests and as NOS surplus (loktal tubes in general are pretty deluxe in my book—the 6SL7/6SN7 can be replaced by their loktal versions, 7F7 and 7N7, so that all sockets can be the same). Some may be reluctant to try out these 'weird' tubes. However, they are easy to find in quantity for reasonable prices and the quality of available stocks is high. Note that the pin layout of the loktal tubes is symmetrical. This configuration lends itself to elegant and electrically sound wiring practice.

Parts quality has a great deal to do with the sound and fury of a design. Remember that the simpler the design is, the greater the influence of individual parts and circuit materials generally on the sound. We are dealing with an amplifier which will not disguise these effects, but will depend on them.

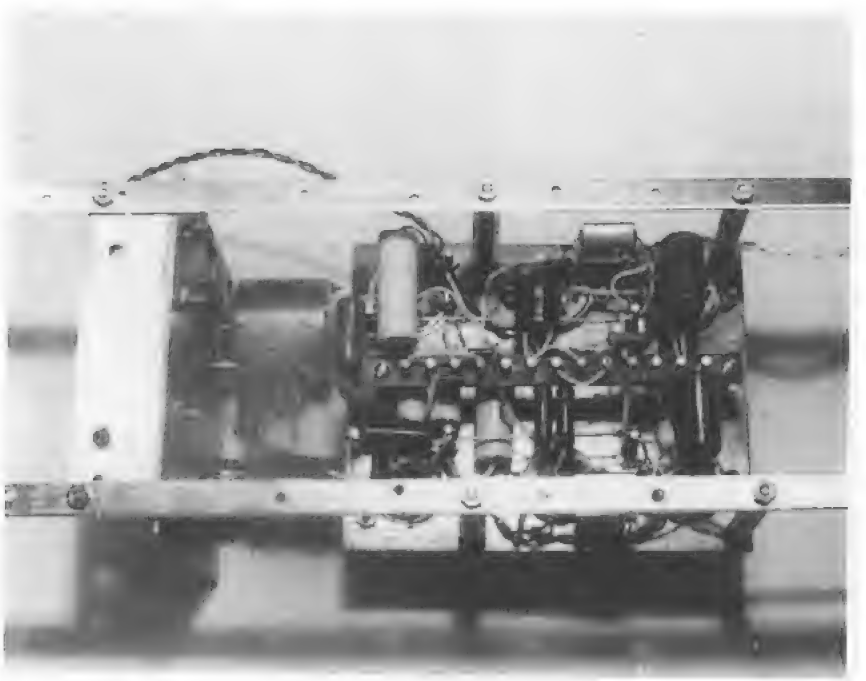
For resistors, I recommend that you always use wire-wound resistors, non-inductive if you can find them. The capacitors you use will also impart a distinct flavor to the resulting sound of your project. Metallized caps are worst. Film and foil, regardless of favored insulator, are always better sounding. Powder, dust, chunks, and aggregates are precisely where "grain" (a completely weird and overworked metaphor if there ever was one...) comes from.

Avoid "graininess" in the literal sense when choosing your materials. The material that sits in the signal path matters most, so spend your money wisely if you're on a limited budget.

Wire is a fascinating subject all by itself. The jury is far from in when it comes to what is good and why. I found that solid core wire, copper or silver, has an earthy, tangible sound to it. At one time, I had a system that was solid-core wired from the turntable to the speakers, and it possessed some of the most tactile sound ever to visit my home. However, it was definitely at a loss in portraying "air." These days, I mix solid-core and stranded wire in my system, moving from finely stranded at the cartridge to solid-core at the drivers. I lost a bit of that "weight" I heard with all solid-core but it is much more delicate in the more critical middle and top with a blend of wire types.

DESIGN CHOICES

The choice of a 6SL7/5691 as the first amplifying device is worth elaborating on. The first stage has more influence on the basic character of a system than any other part except the speakers. This is a high mu (lots of gain) triode of exceptional linearity. Reliable and rugged, its various forms and mutations make an interesting study in tube lore and they all sound just a little different. These qualities, plus the nearly lewd emphasis on midrange warmth this tube brings to the party, make it an ideal candidate for an input tube. If the record has anything good going on the middle, this device will have a field day with it.



This choice also represents the single most important compromise in this design. In order to get the necessary gain in the first stage, while maintaining a low noise floor and low distortion, we must accept a reasonable loss of transient information. The 6SL7 doesn't have the transconductance to compete with a 6SN7, 6DJ8, or 12AT7 in this regard, although it is marginally better than a 12AX7. A touch of 'softness' in attack and decay is a small price to pay to avoid feedback.

The impact of this design decision errs totally on the side of delight. The 6SL7, as a plate loaded amplifier, imparts a 'Rubenesque' shimmer to classical music and Opera. The industrial 5691 is THE *ne plus ultra* voltage amplifier for vocal music! (Blues!) We are concerned here with nuance—the tonal balance is close to perfect (the tube is very linear) but slightly forward and more lacy (sensual) than real life. This tube can make bad recordings sound okay.

Note that the 6SL7 is current-sourced. This is important because it provides an increased measure of isolation from the power supply and lower harmonic distortion. The 1N5309 is a Motorola part of high quality—1N5309s can be hard to find; try Homemade Electronics. I am not anti-solid state. I am pro-whatever it takes to make it rock the house. FET current sources work real good. A current source is vastly superior to a resistor in this application and I was very happy with the improvement it provided.

The stages which follow can be much more grid sensitive because we will be dealing with a signal of greater amplitude. A 6SN7 is next in line. It has double the transconductance (3200 umhos) of the input tube. The 6SN7 is the laboratory standard; what goes in is what comes out. It imparts an earthy tangibility to the performance of the preamp and complements the ethereal sweetness of the 6SL7 very nicely.

6SN7s have been unjustly criticized as cold, dry, or overly analytical. Perhaps the overuse of this tube as popularized in the classic Williamson circuit merits some blame for this misconception. One should never use the same type of tube more than once in any system to avoid additive effects. In some cases you can have one stage of a particular tube in a preamp and one and *only* one additional stage using the same tube in the power amp, but this is pushing it. Cascading the same tube type simply multiplies both the flaws *and* the graces. You can get too much of a good thing and that's no good. [Ed.- Thought you were a hedonist! *Poseur*!]

The 6SN7 is probably (along with the 5687 and 6CG7) one of the most linear common audio voltage amplifier tubes. It is really even handed, but gang two or more together and they can rip your ear drums apart. 5692s are warmer but tend to be microphonic so you will have to select them carefully for preamp use. Among 6SN7s, the GE 6SN7GTBs with a side getter and the Sylvania WGBs are my personal favorites.

The third and final stage of the preamp has a particularly demanding role because of the way RIAA equalization is implemented in earlier stages. Most of the actual gain the entire circuit provides comes from this tube. The 7F8 is a Class A RF dual triode that offers relatively high gain *and* high transconductance. The input capacitance is controlled for RF applications and this makes it useful as a wideband amplifier. This is actually a great candidate for an input tube also, but I'll let *you* build that one! In this circuit, both sections of the tube are paralleled to lower source impedance and increase sensitivity. The 7F8's basic character is punchy and focused. It adds drama and a gilt edge to the 6SL7/6SN7 combo.

The power supply is very straightforward. You can practice whatever religion you adhere to. If you're unsure, just do what you see in fig. 3. Be sure to keep the phono stage well isolated from the power supply. Build a separate box if you like (your stripped out Audio Research preamp might do nicely...). Forgive my lack of enthusiasm for well known names and collectibles. The ideal musical preamp has NOT been 'discovered' by the Big Guys of the commercial audio world. This is not to say that it can't be done, but the priorities of the business world do not always completely overlap those of the lover of music and records.

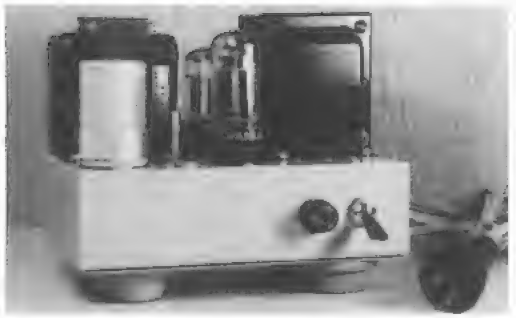
It is important to begin fresh, and the first thing before us is to put some miles between our music and "neutrality," whatever that really means. Preamps, amps, and speakers are a platform for our obsession with music and art, not a faceplate for some ascetic moral position.

THE AUTHOR
J.C. Morisson inhabits the basement workshop at Fi in Lower Manhattan where he subsists on a diet of cold coffee and solder fumes. His projects include artisanal electronics and high sensitivity speaker systems for the hedonistic audiophile.

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A 5 WATT 6BX7GT TRIODE AMPLIFIER

by Ed Warden

Here's a simple push-pull triode amplifier I built while I was snowed in during the Great Blizzard of 1993. It provides the silky smooth and vivid sound that triodes are famous for. At 5 watts output, it is a practical amplifier for use in an apartment-sized living room when speakers of reasonable efficiency are used.

This project would provide the newcomer to tube amplifiers an excellent introduction to the advantages of triode output stages. For those of you who are thinking of taking the plunge into triode amps, but remain unconvinced of the real world capabilities of low power triode amplifiers, try this one. This is a project that can be constructed for a minimum outlay of cash which will give you a taste of what it's all about. At comfortably loud (i.e. civilized) volumes, it is a joy to listen to with my old Jensen bass reflex speaker.

The amplifier will provide 5 watts output without clipping using a sine wave test signal. Using a music test signal, the amplifier will provide 6 watts on peaks without clipping. Fixed bias instead of cathode bias is used in order to reduce distortion and to provide a slightly higher power output.

As indicated on the schematic, a B+ plate supply of about 300V should be used. If a much higher voltage (e.g. 400V) is employed, crossover distortion will result because the increased bias voltage required to keep the total plate dissipation within the 12 W rating will move the operating point of the 6BX7 into a non-linear region.

The bias pot should be adjusted so that 0.34 V is measured across the 10 ohm resistor at the cathodes of the 6BX7 under no signal conditions. This will result in a total plate dissipation of about 10 watts and it will put the 6BX7 into a linear operating region.

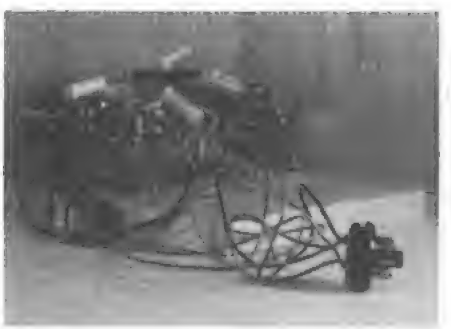
I tried 6 dB of negative feedback in my amplifier but found that it sounded better without it. The distortion of the 6BX7 is already very low without negative feedback. I thought that feedback gave the amp a slight "muffled "sound.

A 1 V RMS input signal will drive the amp to full output. Without any negative feedback, the frequency response of the amplifier is within 1 dB from 10 Hz to 20 KHz at 1 W output.

I used the output transformer from a junked Fisher integrated amplifier. I estimate the power rating of the transformer to be about 25 watts—overkill for my amp. The load impedance of triodes is not critical. Any output transformer with a primary impedance of around 5K to 8K should work fine. The output transformer I used measured about 5.5K. A higher load impedance will give you slightly less distortion with a slight decrease in output power. It should be easy to scavenge suitable iron—outputs from just about any 6L6, 6V6, or EL84/6BQ5 amp will do. All other parts are available from Antique Electronic Supply, Radio Shack, or Allied Electronics.

Time required to breadboard the amplifier was under one hour. After testing my circuit on the breadboard, I built the final product on a 5" X 7" X 2" steel chassis as shown in the photo. I built the chassis based amplifier in about four hours.

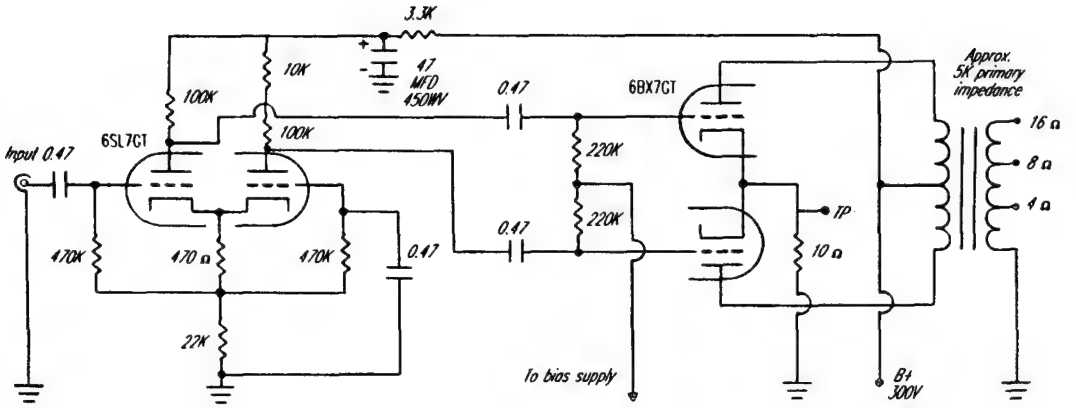
Note that a 10K resistor is in series with a 100K resistor in the plate circuit of the right half of the 6SL7. In this type of phase inverter (cathode coupled Schmidt type), the total resistance in the second half of the tube should be about 10% higher than the plate resistance in the input section in order to obtain equal amplitude signals from both of the phase inverter's outputs. This type of phase inverter has excellent characteristics with respect to low distortion, low phase shift, and equal frequency response for both outputs.



Breadboard set up for testing



Top view of finished amplifier. Note bias test point and bias adjustment pot located next to filter cap.



T1— 650VCT @ 40 ma, 6.3VCT, 5V, Allied Electronics #6K3VG or equivalent.

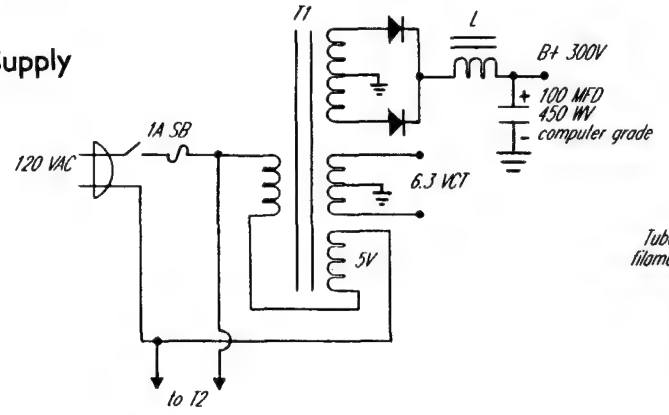
T2— 25.2VCT @ 450 mA Radio Shack #273-1366.

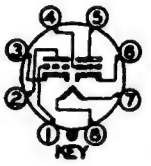
L— 8 H @ 60mA, Antique Electronics Supply #PT-151 or equivalent.

Diodes are 1N5408 (1000 V, 2A), 1N4007, or similar.

All resistors are ½ W carbon film—except where indicated Signal capacitors are 600V plastic film type.

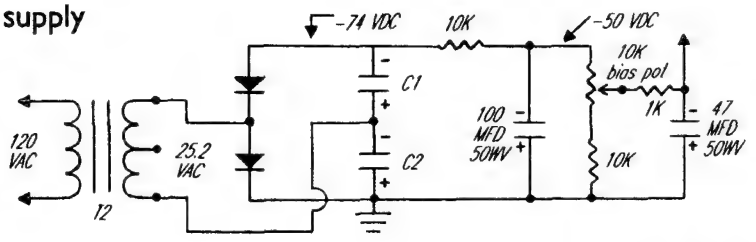
B+ Supply





Base Diagram
6SL7 and 6BX7

Bias supply



C1, C2— 100 mfd @ 50VDC

NOTES ON POWER SUPPLY

The 5 volt winding is connected in series with the primary of T1 in order to reduce the output voltages slightly so that the B+ will be 300V and the filament voltage will be very close to 6.3V. Without this connection the output voltages were a bit too high with the particular transformer I used.

If output voltages are much higher than indicated *under load*, reverse the connections of the 5 V winding. One way boosts the output voltage, the other way lowers it.

Be sure to observe correct polarity of diodes and electrolytic caps.

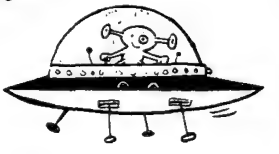
AUDIO NOTE UK OUTPUT TRANSFORMERS

15 W for EL84 PP 9K-6 ohm	$70
15 W for EL84 PP 9K-4/8 ohm	$80
25 W for 2A3/300B PP 5K-4/8 ohm	$110
25 W for EL34/6L6 PP 6K-4/8 ohm	$100
50 W for KT88/6550A PP 6K-4/8 ohm	$130
50 W for EL34/6L6 PPP 3K-4/8 ohm	$130
50 W for 845 PP 11K-4/8 ohm	$215
15 W for EL84 PSE 2.6K-4/8 ohm	$150
25 W for 2A3/300B SE 2.5K-4/8 ohm	$165
50 W for 2A3 PSE 1.2K-4/8 ohm	$220
25 W for EL34/6550A PSE 1.5K-4/8	$175
30 W for 211/845 SE 10K-4/8 ohm	$210
50 W for 211/845 SE 10K-4/8 ohm	$225
50 W for 300B PSE 1.25K-4/8 ohm	$265

PP = Push-Pull, PPP = Parallel Push-Pull, SE = Single Ended, PSE = Parallel Single Ended. All have frequency response well beyond the audible range. More models available soon, including 60 W for KT-88 PP 4.3K with Ultralinear screen taps - 4/8/16 Ohm (for Mark III, etc.)!

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from the archives

Passive Crossover Networks for Bi-Amplifier Systems

by Blaine B. Kuist

This article first appeared in AUDIO, November 1969. With *yet another* resurgence of interest in multi-amp systems, let's take a rearward look. . .

Electronic crossovers are getting the spot-light in a resurgence of interest in bi- and tri-amplification (high, intermediate, and low frequencies split ahead of the power amplifiers).

A lot of hi-fi buffs might be interested in an alternative that is simpler to build (2 hours), not too costly ($50 for two channels with one crossover point), high in reliability with few components and top performance.

The alternative is the old work-horse—passive L-C filter networks.

An article about Electronic Crossovers[1] intrigued me with the potential of improved sound with bi-amplification. My hi-fi fever set in last spring after looking for a starter outfit with my teenage son. Casual looking and listening led to growing interest.

I wondered why a treble speaker like the Altec-Lansing 802-D driver and 511-B horn couldn't be teamed with a good 15-in. speaker, thus covering the whole audio range with just one crossover. By now I had eagerly waded through some of the good handbooks for hi-fi hobbyists, such as "Speaker Enclosures," by A. Badmaieff and Don Davis,[2] and "Hi-Fi Projects for Hobbyists," by Leonard Feldman.[3]

From current literature from manufacturers like Sony, Bozak, C/M Labs, and Pioneer, a tailored design (for a selected crossover frequency and cutoff slope) of an electronic crossover appeared to be a tough project for a beginner to tackle. Fortunately, I talked to a professional audio engineer about my interests. His reaction was, "Why not use high- and low-pass filters?"

The key idea was to feed the filters from the pre-amplifier, matching the 600-ohm output impedance of the pre-amplifier with a 600-ohm input impedance of the filter. The 600-ohm output impedance of the filter was also matched and terminated by a 600-ohm resistor (in parallel with the 100-k ohm input impedance of the power amplifier). Thus the filter was matched at the input and output with 600-ohm constant impedances.

SETTLING ON FILTERS

This sounded simple enough—until I tried to find the filters. A search of electronic catalogs, stores, and magazines indicated filters were readily available with 18 dB/octave cutoff slope of the constant-*k* type but would have to be special-ordered for the 12-dB slope which was desired. Perhaps these are available from some professional audio equipment suppliers but my hurried searches failed to turn them up.

So it was back to the "do-it-yourself" method which didn't disappoint me, really. *Audio's* articles on "Professional Audio Controls"[4] had a reference to Howard Tremaine's comprehensive handbook on *Passive Audio Network Design*.[5] This had the practicalities of filter design and construction spelled out.

Again with simplicity in mind, I focused on parallel high- and low-pass L-C filters involving the familiar networks of conventional speaker crossovers except being designed for 600 ohms instead of the usual 4, 8, or 16-ohm speaker voice-coil circuits.

Fig.1— Schematic of the passive filter networks used with the bi-amplification system described by the author. Two networks are required for stereo.

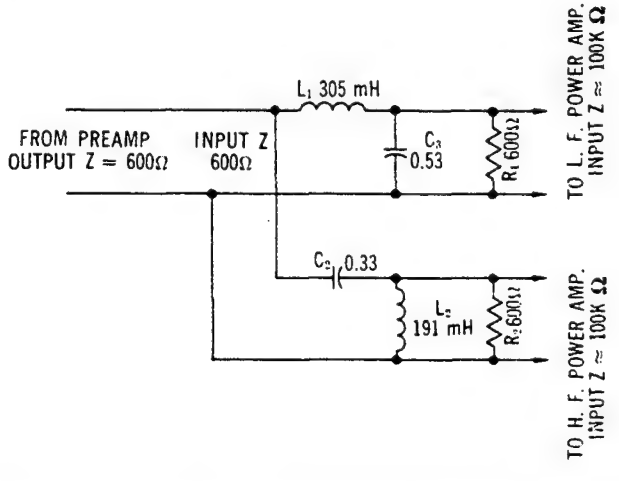
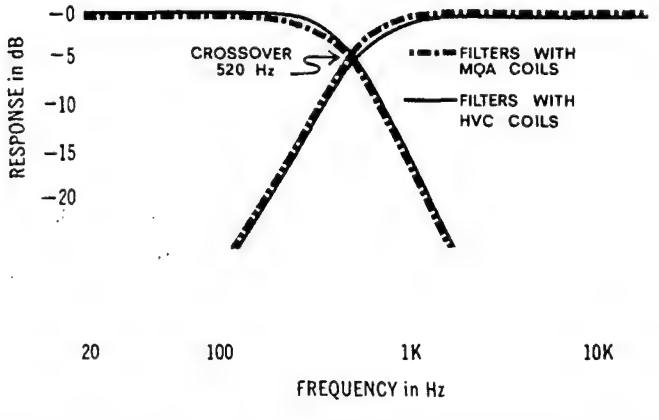


Fig.2— Frequency response curves for the author's passive networks.



	PASSIVE (before amplifier)	ELECTRONIC	CONVENTIONAL (after amplifier)
Bass damping and transient response	Permits performance to full damping ability of amps	Same as passive	Reduces woofer response by resistance and reactive impedance between amp and speakers
Amplifier performance	IM distortion minimized by separate amps for high and low frequencies	Same as passive	IM distortion due to high and low going through same amp. Dynamic range linited because power peaks for high and low are additive
Speaker distortion	Minimized— None due to crossover frequencies shifting	Same as passive	Crossover frequency and phase of highs and lows shift with impedance variations of speaker
Insertion loss or gain	-3.5 dB	0 to +3dB typical Some types, -6DB	Depends on quality (high Q) of particular coils used. -0.1 to -2dB typical

TABLE I: Comparison of Crossover Alternatives

The filter networks selected and built are described as follows:
Parallel, *m*-derived
m = 0.6 for constant impedance over 85% of transmission band
Impedance in and out: 600 Ohms
Crossover frequency: 500 Hz
Attenuation at crossover: 3dB
Slope of attenuation: 12 dB/octave

The component values are derived from these formulas:

$$L_1 = (1 + m)\frac{Ro}{2\pi fc} \text{ Henry}$$

$$L_2 = \frac{Ro}{2\pi fc} \text{ Henry}$$

$$C_2 = \left(\frac{1}{1+m}\right)\frac{1}{2\pi fcRo} \text{ Farad}$$

$$C_3 = \frac{1}{2\pi fcRo} \text{ Farad}$$

Where R_o = filter characteristic impedance
fc = crossover frequency

In rounding up material to build the filters, we found the capacitors were readily available but the inductances were another matter. With values of 191 and 305 mH needed, air-core coils were out of the question because of large size and hence large resistance. Little usable information seems to be available for constructing iron-core inductors so it was back to the catalogs. Coils with desired characteristics were rarely listed and hard to find. However, the United Transformer Company catalogs listed coils that covered the audio-frequency range with Q's of the order of 10 to 30 at the 500 Hz crossover point.

For the first pair of coils, the HVC Variductors were tried because they were adjustable and available at a nearby electronic store. The coils were finally set reasonably close to the desired values but they were sensitive to set, although once set, they held their settings and worked well.

For the second pair of coils, the MQA fixed inductances were chosen. These high "Q" toroids with inductances of +/- 1 per cent, the numbers closest to those desired without a special order. This compromise on inductance from the desired 191 and 305 mH was not significant.

A description of the coils used follows:

	mH	DC mA	DCR
Filter A			
HVC-4 Variductors	30-300	30	8.6 ohms
HVC-5 Variductors	70-700	20	22
Filter B			
MQA-8 Hi-Q Toroids	200	50	16
MQA-9 Hi-Q Toroids	300	40	25

Typical "Q" curves for the metal core coils rise to a peak then fall off after the saturation point of metal cores is reached. The peak Q (about 160) for the MQA coils occurs at about 5 kHz. At the crossover of 500 Hz the Q is about 40. At 20 kHz, Q is about 25 and at 20 Hz it is in the range of only 1 to 2.

The HVC coils being adjustable, the peak Q falls somewhere in the lower half of the audio range depending on the setting. At 500 Hz the Q is in the range from 5-15.

Although the MQA coil had in general the higher Q characteristics, there was no audible difference in performance.

FILTERS ASSEMBLED

With the coils in hand, the remaining parts were readily available and assembly went fast. All the parts were mounted on a plastic board fastened to the cover of a 4" X 5" X 3" steel box. Steel was used for shielding although this was later found to be unessential.

Response vs. frequency curves were run with an audio generator and a VTVM with the results shown in Fig. 2. The 520 Hz crossover point was close enough to the 500 Hz goal.

The crossover point was down 3.5 dB from the bass plateau and 4.0 from the treble, vs. the goal of 3.0. Theoretically, the total sound pressure level should then suffer a bit of a drop in the crossover region. Practically, this slight dip could not be measured in the total output from the speakers (audio generator input and microphone

WAVELENGTH
AUDIO

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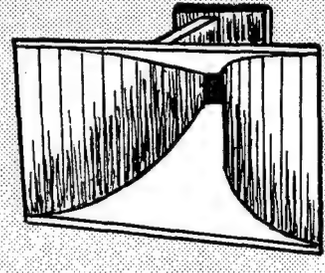
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pickup) and certainly could not be detected by ear. The insertion loss was 3.6 to 3.2 dB (20 Hz and 20 kHz respectively).

As the text books state, distortion for the passive filter network should be practically nil. This was checked through the courtesy of a manufacturer's amplifier clinic and proved to be so. The filters were used between a Dynakit PAT-4 preamplifier and two Dynakit 120 amplifiers. The THD was measured at 2 volts output, which would fully load the amplifiers when feeding 16 ohm speakers. No difference could be read in the THD with and without the filters in the output.

In my setup, the amplifiers were fed into the Altec-Lansing treble horns mentioned earlier and Klipschhorn bass corner horns. The defenders of the conventional crossover have pointed out that the electronic crossover (or filter) ahead of the amplifiers adds little or nothing to the damping of the bass speaker which is horn loaded like the Klipsch. Theoretically, this might be right. I have not had the opportunity yet to check this with A/B tests of conventional crossovers vs. filters with the horn loaded speakers. probably the differences are less prominent than with direct-radiating speakers. All I can say at this point is that the sound from the horns with the filters ahead of the amplifiers is superb.

If you have been following the interesting articles and letters to the editor in *Audio* Magazine for the last year and a half on this subject, you are pretty well posted on the pros and cons of electronic crossovers vs. conventional crossovers after the amplifiers.

This article presents another alternative, passive filter networks ahead of the amplifiers. Comparing filters with electronic crossovers, it appears that there is a lot to be said for the filters, especially for the audiophile who wants to build the device himself with minimum time and cost. Advantages and disadvantages of the three alternatives are listed in Table 1.

The debates continue on whether the sound is significantly better (and worth the cost) with the crossover ahead of the amplifiers. To anyone who has listened to an A/B test with direct radiating speakers, there is no doubt about the result being audibly better with crossovers ahead of the amplifiers. And for the audio buff who is determined to get the best in sound, an easy, economical, and reliable way to do it is with passive filters.

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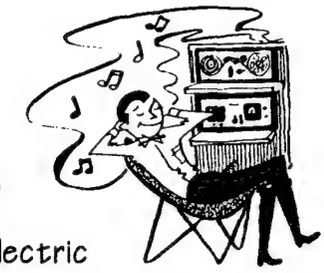
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Casual Reactions



by Herb Reichert, Eddy Electric

THE NEED TO PARTY = POTENTIAL DIFFERENCE

About ten years ago, I decided to try to learn electronics so I could build my own amps. I bought a book called *Electronics Made Simple.* A week later, I had to buy a book called *Mathematics Made Simple.* It seemed I couldn't learn electronics without mastering some math concepts. Woe to a misspent youth! If I could have bought Kenn Amdahl's book *There Are No Electrons: Electronics for Earthlings,* I would have known that an amateur can understand electronics better than a pro—without doing a single calculation.

When someone suggested that I review a book where the tireless "need to party" of imaginary beings called "little greenies" represented voltage, I thought I was hitting a premature journalistic bottom. To my surprise, I learned an amazing amount rethinking what I already knew, things that I had learned the hard way.

It works like this: the chicks buy the kegs of beer and turn up their radios. The brothers hear that rock and roll, get in their little green cars, and motivate toward the music. That's current. If there are a bunch of greenies cruising down a wire, you can bet they are heading for a party. Now that you have the concepts of voltage and current, you can read on to discover resistance (traffic jams), heat, work, circuits, swimming ducks (magnetism), pale skinned magicians, jargon, and the beautiful and sensuous Belinda.

This book uses wonderful stories to elucidate difficult concepts. At the end, the reader "owns" these electrical concepts. More importantly, a person in possession of the author's conception will find the world more exciting and magical. *There Are No Electrons: Electronics for Earthlings by* Kenn Amdahl, © 1991, 321 pages, $12.95 (ISBN 0-962-7815-9-2) is available direct from the publisher:

CLEARWATER PUBLISHING CO., INC.
PO BOX 1153
ARVADA, CO 80001-1153

MIKEY SAYS : "WHODUNIT?"

With audio mags I always read the ads and manufacturers' comments first. Maybe it's like finding out "whodunit" before starting the book, but it's fun. In 1992, Audio Note "done it" with their ads in the back of *Hi-Fi News and Record Review.* Silver foil caps at $1400 and Black Gate caps at $100!! Everybody must have stopped there for a minute. What's next though is just as wild—oil and paper caps at $7 and single ended output transformers for around $160! Compared to Vitamin Q and Tango this seemed a bit on the cheap side. Could they possibly be any good?

I was happy with the Tango and Black Gate products I had been using for years, so I decided to wait until somebody else tried the Audio Note products. Why should I be the first sucker? Here's why—I have a SE amp that allows me to change transformers and coupling caps as quickly as I can change a record. I also have an SRPP passive EQ preamp set up so that I can change caps while the music is playing. That makes me "Mikey," as in "Let Mikey try it: he'll try anything."* Well, in case you were wondering. . . the editor sent me some Audio Note paper-in-oil caps and a pair of A.N. 300B SE outputs.

I compared the oil caps to my reference: Component Research teflon caps. I also compared them to MIT Multicaps (RTX), RT Rel Caps, Roederstein MKP 1845s, and Sprague 192P Vitamin Qs. I auditioned them at both low (preamp) levels and high (power amp driver stage) levels.

In my experiments, I've found that caps usually add a "flavor" consonant with the material of their dielectric. That is, if I were to make little bells out of teflon, polypropylene, polystyrene, and oiled paper, the sound of each would be similar to the coloration each adds to the musical tones. This leads me to speculate that the AC signal is an electromechanical shock wave that excites the resonant quality of the material it passes through. "Well," you say, "the paper and oil probably adds the least to the sound. Those oiled paper bells don't ring too loud." Sure enough, I applied a lot of energy trying to ring them but they simply absorbed the energy from my wrist.

What I mean to say is that oil caps like Vitamin Qs used at low signal levels always gave me dulled transients, a loss of information, and a reduced sense of pace and timing. Tired musicians? But oil caps also provide a beautiful, easy, relaxed quality that is very seductive and "natural." They work well at amplifier signal levels but for preamps, forget it. Death.

Plastic caps always sound like plastic. Polypropylene sound best at high levels and polystyrene at low levels. Teflon almost disappears at any signal level. So I often use teflon at low levels and oils at high levels, working for a pleasing balance. At retail, both of these types cost $20-$40 each. I found that the Audio Note paper-in-oil caps have the speed, transparency, and vanishing qualities of teflon combined with the natural ease of oil caps. Plus, they work everywhere. Mikey likes them. Finally, an oil cap with *life*!

I liked the single ended 300B/2A3 outputs too; in fact, the caps and the transformers seemed to have been made by the same hand. They both have the best qualities of what we sometimes call "the UK sound." If you have a Linn turntable or a pair of LS3/5As, you already know the character of these outputs. In fact, I'd bet the Linn deck, LS3/5As, and 300B SE amps with the Audio Note trannys would make a great little system. To be more specific, the AN transformers were extended but definitely light in the bass, a little bit thin through the mids, almost perfect in the highs, and outstanding rhythm masters overall. As the Brits say, "Very tuneful." As the Americans say, "Best buy."

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* Interesting hobby there, Mikey.

A ONE-TUBE REGULATOR

by Mike Vans Evers
Clarus Recording Products

Tube regulators were invented in the 1930s to replace the bulky battery power supplies used with scientific instruments. There were many types, some simple, some complex. The regulator presented in this article is of the simple variety: one tube. The benefits of a single tube regulator are simplicity, compactness, low cost, and minimal heater supply requirements. The disadvantages are limited output current (about 35 mA for the unit described here) and only moderately low output impedance compared to more complex types.

"Why tube regulators?" you're asking yourself. Well, there are good reasons for and against. Some people like the sound of unregulated supplies because "raw" supplies sound more warm and tubey. Others like the sound of regulated supplies because they feel that regulation gives the sound more impact and focus. Some prefer the sound of tube regulators because they find that tube based regulators sound more natural than the solid state variety. All elements in a design affect the sound of that design. The power supply is a major element in any design. The decision to regulate or not to regulate will ultimately be decided on the basis of the resulting sonic qualities—hopefully.

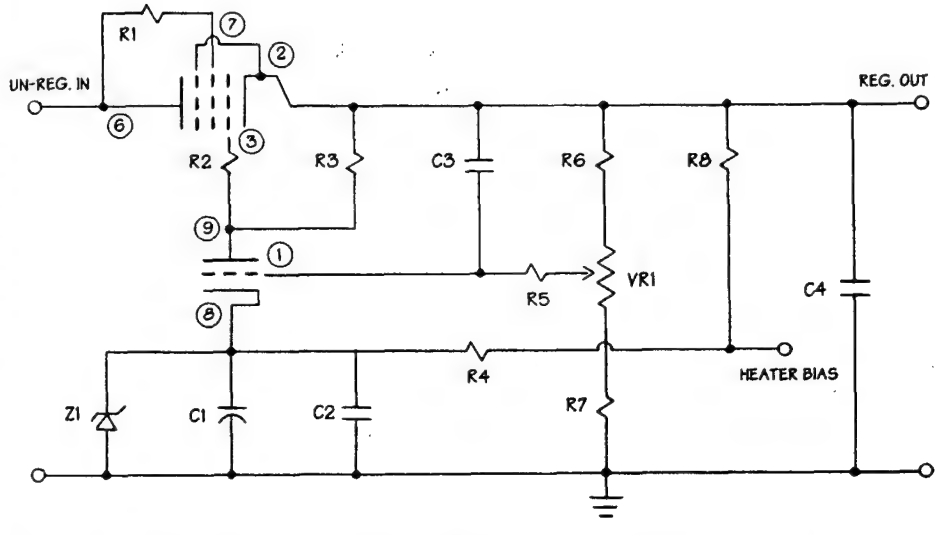
The tube used in this circuit (Fig.1) is the 6BM8/ECL82. It is a power pentode and high mu triode in one envelope. The pentode element is used as the pass element. It is triode wired to reduce its internal impedance, which in turn lowers the internal impedance of the regulator. This pentode has an amazing maximum plate supply rating of 900 volts. Because of the high plate supply rating, silicon diodes can be used for rectification with minimal danger of cathode stripping. Also, since the 6BM8 is an indirectly heated tube, it will provide a slow turn-on characteristic.

The triode section of the 6BM8 is used as the error amplifier. A voltage divider is placed across the output of the regulator in order to sample the DC output voltage. This DC voltage is fed to the grid of the error amplifier.

Because the voltage divider decreases the output voltage to the proper range for input to the grid, it also proportionately reduces the amount of the regulator's residual ripple seen by the error amplifier. This is not good, so we bypass the voltage divider with a capacitor so that all of the ripple is seen by the error amplifier. The cathode of the error amplifier is held above ground with a zener diode. Of course, 50 years ago they used reference tubes like 0A2s to do this, but they take up lots of space and they don't provide as reliable a reference voltage as a zener diode does with only a few mA of current.

The value of the zener can be changed to vary the range of output voltages up or down. However, the maximum heater to cathode voltage is only 100 V, so the maximum output voltage should be limited to the zener voltage plus 200 V.

Zener diodes are noise generators and their internal impedance is far from zero. For these two very good reasons, the zener diode is bypassed with a combination of electrolytic and film capacitors. The plate resistor for the error amplifier is connected to B+ regulated instead of the more usual connection to B+ unregulated. Taking the error amplifier's plate current from the regulated output improves the regulation, while using only a minute portion of the available output current of the pass element.



R1 - 470 - ½ W
R2 - 10K - ½ W
R3 - 270K - ½ W
R4 - 62K - 1W
R5 - 10K - ½ W
R6 - 220K - ½ W
R7 - 120K - ½ W
R8 - 100K - ½ W
VR1 - 100K ½ W 10 turn
C1 - 33µf/250V
C2,3,4 - 1µf /400V polyprop.
(#) tube pin number

Fig. 1— A one tube 6BM8 regulator circuit

When the maximum current is needed from this regulator, B+ unregulated must be at least 70 volts higher than the regulated output. This condition is progressively relaxed as current requirements are lessened, i.e. the less current you need, the fewer volts have to be thrown away across the regulator.

If you decide that you don't like regulation after all, you can rewire this circuit as a nifty line stage with 12 dB or more gain (Fig.2). This circuit will drive 600 ohm 'phones admirably. We may offer stuffed circuit boards, tubes, and kits to those adventurous souls who want to explore the world of tube regulators. For more information, write me care of Clarus Recordng Products, 1248 E. Hillsborough Av., Tampa, FL 33611.

ZENER DIODE SELECTION GUIDE

Voltage rating vs. desired V_{out}

ZENER	Min V_{out}	Max V_{out}
75V	140	240
100V	205	300
120V	240	320
150V	310	350

Do not exceed Max V_{out} listed above for a given zener rating even though adjustment above this value may be possible.

Five watt units are suggested for all zener values above. A 1W zener will work fine electrically but 5W zeners will provide for lower noise performance.

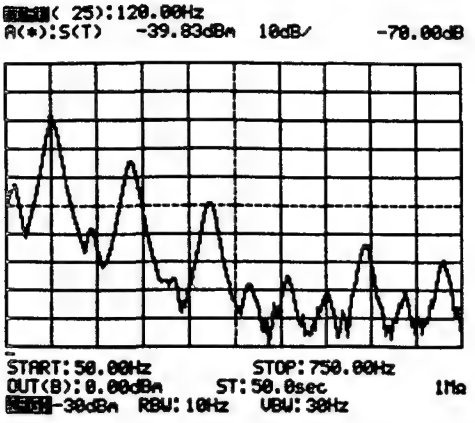
MEASURED REGULATION

from no load to load = RI

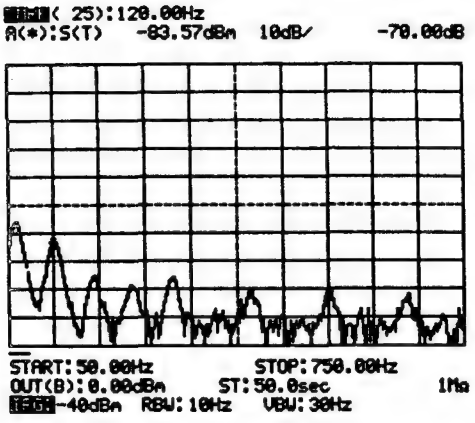
385 V_{in} / 300 V_{out} @ load = RI

Stability from line variations is less than 0.23% change under above range of conditions within an input voltage range of 358 V - 412 V.

RI (ohms)	% change in Vout
50 K	0.096
45 K	0.10
40 K	0.13
35 K	0.13
30 K	0.14
25 K	0.16
20 K	0.19
15 K	0.32
10 K	0.33



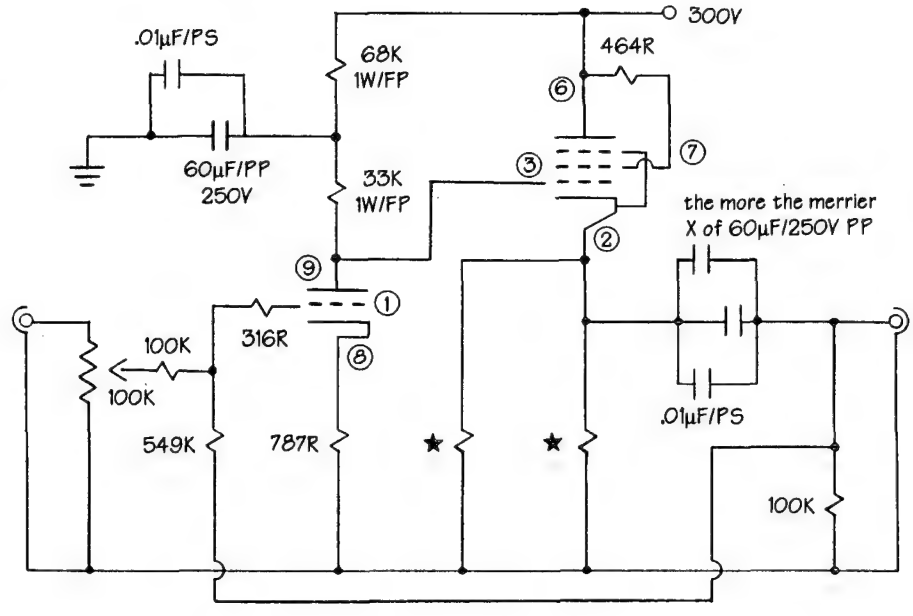
Noise spectrum - Pi filtered unregulated DC



Noise spectrum - 6BM8 regulator with *pi filtered unregulated DC supply*

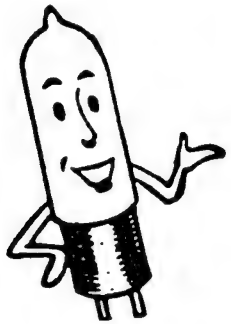
Left: These graphs are spectral analyses of the noise and garbage seen at the output of the 6BM8 line stage described below with a) an unregulated pi-filter supply (80 mF + 50 ohm 10W wirewound + 100mF) and b) the 6BM8 regulator described above installed after the pi filter.

A 40+ dB drop in noise and line harmonics will make the background much quieter, thereby letting much more low level detail through.



★ for line only- 2 of 10-12K 5 or 10W ea.
for 600Ω phones or line- 2 of 8K 10W ea.

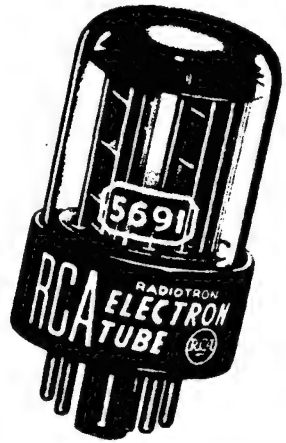
Fig. 2—Schematic of 6BM8 line amplifier derived from the one tube regulator circuit.



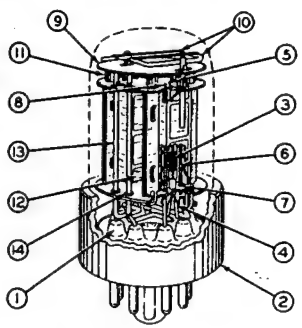
Meet the Tube. . .

RCA *Special Red* TUBES

5691, 5692, 5693



1— Low-leakage button stem.
2— Non-hygroscopic base
3— Pure tungsten heater for high mechanical strength
4— Sleeves on heater legs insure good mechanical and electrical bond between heater and heater leads.
5— Cathode sleeves locked to mica insulator.
6— Grid plated to minimize variation in contact potential.
7— "Stops" prevent vertical movement of grid rods.
8— Grid rods fit tightly onto mica insulators.
9— Extra mica insulator provides getter shield.
10— Two getters for long life.
11— Plates held rigid by plate ears wedged into mica insulators.
12— Plates are designed to minimize electron coupling between units.
13— Mount secured by five supporting rods.
14— Twelve reinforcing eyelets provide a firm bond between mica insulators and supporting rods.



Internal Structure of RCA-5691 and RCA-5692

Sometimes it pays to put your money up front. Like when a $3 part failure can shut down a million dollar operation or cripple vital national defense systems. Or where replacing that $3 part could cost hundreds or even thousands in maintainance fees. Back in the early Sixties, when a garden variety 6SN7 cost $2.60, the 5692 Special Red version went for $8.75. Small change compared with a Saturn V rocket crash or accidental launching of a few ICBMs. The RCA Special Red tubes are parts for applications that matter. They are rated for 10,000 hour service where "extreme dependability and exceptional stability are paramount."

When you see one, you'll recognize that it's SPECIAL at a glance. Bases are bright firehouse red. Internal construction is also top notch. Extra mica spacers and vertical support rods provide mechanical integrity for applications where vibration and high G forces (rated for 500g impact!) are encountered. Everything is braced and tightly connected together. Heaters of the twin triodes are wired in series for fail safe operation. In terms of build quality, they are in a select class among small signal tubes.

There were four red tubes: a high-mu twin triode, 5691, a medium mu twin triode, 5692, a sharp cutoff pentode, 5693, and a full wave rectifier, 5690.

The twin triodes were similar to the standard 6SL7, 6SN7, and 6SJ7, respectively. The 5690, an unusual design in that each half has its own heater and cathode with separate pinouts, is rarely encountered and has no entertainment or industrial grade substitute. Together this group of tubes can meet design requirements for many applications.

This series of tubes was produced by several manufacturers besides RCA: GE, CBS/Hytron, Westinghouse, Tung Sol. Not all suppliers provided the distinctive red base of the RCA. Some used a low-loss light brown mica impregnated base which lacks the visual drama and color symbolism of the RCA version.

Red tubes were typically found in vacuum tube computers, aviation and aerospace instrumentation, laboratory apparatus, vital telecommunications installations and other critical industrial applications.

Although relatively hard to source and expensive compared with standard 6SN7, 6SL7, and 6SJ7 types, they are a favorite of audio experimenters everywhere. It's the tube to use when you care enough to select the very best.

"Whenever the accent is on quality — and quality alone"

RCA 5691
HIGH-MU TWIN TRIODE

RCA-5691 is a high-mu twin triode designed and manufactured for critical industrial applications. In such service, it is particularly useful as a voltage amplifier. In addition to the structural features illustrated above, this type has its heaters for the two triode units connected in series so that failure of either heater in bridge circuits makes both units inoperative.

The 5691 is similar to the 6SL7-GT except that it has twice the heater current (0.6 A). It is recommended as a replacement for the 6SL7-GT only where provision for the increased heater current can be made, only where the operating conditions are within the ratings of 5691, and only where long life, rigid construction and exceptional stability are needed. If the 5691 is operated at the higher maximum ratings of the 6SL7-GT, the full advantages of the 5691 will not be obtained.



RCA 5692
MEDIUM-MU TWIN TRIODE

RCA-5692 is a medium-mu twin triode designed and manufactured for critical industrial applications. It is particularly useful as a balanced DC amplifier, multivibrator, blocking oscillator, and resistace-coupled amplifier. In addition to the structural features illustrated above, this type has its heaters for the two triode units wired in series so that failure of either heater in bridge circuits makes both units inoperative.

The electrical characteristics of the 5692 are similar to those of the 6SN7-GT. The 5692 is recommended as a replacement for the 6SN7-GT only where the operating conditions are within the ratings of the 5692 and only where long life, rigid construction, extreme uniformity, and exceptional stability are needed. If the 5692 is operated at the higher ratings of the higher maximum rating of the 6SN7-GT, the full advantages of the 5692 will not be obtained.



RCA 5693
SHARP-CUTOFF PENTODE

RCA-5693 is a sharp cutoff pentode designed and manufactured for critical industrial applications. In such service, it is particularly useful as a high gain resistance coupled amplifier. This tube can be operated with a grid-No.1 resistor having a value as high as 40 megohms depending on the operating conditions.

The electrical characteristics of the 5693 are similar to those of the 6SJ7. The 5693 is recommended as a replacement for the 6SJ7 only where the operating conditions are within the ratings of the 5693, and only where long life, rigid construction, extreme uniformity, and exceptional stability are needed. If the 5693 is operated at the higher maximum rating of the 6SJ7, the full advantages of the 5693 will not be obtained.



RCA Type	Prototype	Name	Description and/or Difference Between Type and Prototype: Rating or Characteristic	Premium Type	Prototype	Special Tests and Controls: Shock	Fatigue	Vibration	Base Torsion	AF Noise, Microphonics	Stability	Inspectives	High-Altitude	Heater-Cycling	Life Test: 500-Hour	Life Test: 1000 Hour
5690	—	Full-Wave Vacuum Rectifierø	Heater-Cathode Type. Each unit has its own heater and cathode with individual base-pin connections. Full ratings up to 40000 feet.			✓	✓	✓	✓	✓	—	✓	✓	✓	✓	✓	✓
5691	6SL7-GT	High-Mu Twin Triodeø	Heater Current	0.6	0.3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
			Max. Plate Volts	275	300												
			Peak H-K Volts	± 100	± 90												
			Heaters in series for fail-safe operation	Yes	No												
			Controlled Plate-Current Balance	Yes	No												
5692	6SN7-GT	Medium-Mu Twin Triodeø	Max. Plate Volts	275	300	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
			Plate Dissip., Watts	1.75	2.5												
			Peak H-K Volts	± 100	± 200												
			Heaters in series for fail-safe operation	Yes	No												
5693	6SJ7	Sharp-Cutoff Pentode‡	Plate Dissip., Watts	2	2.5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
			Grid-No. 2 Input Watts	0.3	0.7												
			Peak H-K Volts	± 100	± 90												

RCA Type	Cathode: Volts	Cathode: Amps.	Maximum Dimensions (Inches): Length	Maximum Dimensions (Inches): Diam.	Class of Service	Maximum Ratings: Plate Volts	Maximum Ratings: Plate Dissipation, Watts	Maximum Ratings: Cathode Current, Ma.	Maximum Ratings: Grid-No. 2 Input, Watts	Operating Conditions: Plate Supply, Volts	Operating Conditions: Grid-No. 1 Volts(v) or Cathode Resistance, Ohms	Operating Conditions: Grid-No. 2 Supply, Volts	Operating Conditions: Plate Current, Ma.	Operating Conditions: AC Plate Resistance, Ohms	Operating Conditions: Transconductance, Micromhos	Operating Conditions: Amplification Factor	Operating Conditions: Power Output, Watts	RCA Type
5690	12.6 / 6.3	1.2 / 2.4	4¼	1 23/32	Full-Wave Rectifier with Capacitive Input Filter	AC Volts per Plate (RMS), 350 Filter Input Capacitor, 10 μf DC Output Volts at 110 Ma., 355 DC Output Volts at 55 Ma., 415				Max. Peak Inverse Plate Volts, 1120 Max. Peak Plate Ma. per Plate, 375 Max. Av. Plate Ma. per Plate, 62.5 Total Effect-Supply Imped. per Plate, 350 Ohms								5690
					Full-Wave Rectifier with Inductive Input Filter	AC Volts per Plate (RMS), 350 Filter Input Choke, 10 henries DC Output Volts at 135 Ma., 300 DC Output Volts at 67.5 Ma., 305				Max. Peak Inverse Plate Volts, 1120 Max. Peak Plate Ma. per Plate, 375 Max. Av. Plate Ma. per Plate, 75								
5691	6.3	0.6	2⅞	1 9/32	Industrial Service (Each Unit)	275	1.0	10	—	250	−2v	—	2.3	44000	1600	70	—	5691
						Max. Plate Current for Grid Volts at −5.5, 15 μa Difference in Plate Current Between Units, 0.9 Max. Ma. at Grid Volts, −2				Max. Reverse Grid Current, 0.2 μa								
5692	6.3	0.6	2⅞	1 9/32	Industrial Service (Each Unit)	275	1.75	15	—	250	−9v	—	6.5	9100	2200	20	—	5692
						Max. Plate Current for Grid Volts at −24, 15 μa Difference in Plate Current Between Units, 2 Max. Ma. at Grid Volts, −9				Max. Reverse Grid μa, 0.2								
5693	6.3	0.3	2⅜	1 5/16	Industrial Service	300	2.0	10	0.3	250	−3v	100	3.0	1.0••	1650	—	—	5693
						Max. Plate μa 80, at Grid-No. 1 Volts, −7.5 Max. Plate μa 750, at Grid-No. 3 Volts, −70				Max. Reverse Grid-No. 1 Current, 0.1 μa								

ø Glass-octal 8-pin type. ‡ Metal-octal 8-pin type.

•• Minimum megohms.

Classic Tube Regulated Power Supplies

Better take a winch and dolly to the next swapmeet!

by Alan Douglas

SERIOUS voltage stabilization can be yours
for just a few dollars and some manual labor

Why a regulated power supply? What's wrong with a simple transformer, rectifier, and "brute force" filter?

Maybe nothing. But regulated supplies have several advantages over simple filtered ones:

- They can be adjusted to any voltage and, once set, the output voltage is constant, even with variations in line voltage.
- They can make large value electrolytic capacitors unecessary by providing ripple reduction as well as voltage regulation.
- They can allow use of silicon rectifiers while preserving the slow warm-up feature of tubes.
- Their output impedance is low and constant over the entire audio range.

This last feature, low impedance, is the most important. It improves the dynamic voltage regulation, makes decoupling the driver stages easier, and reduces interaction between stereo channels when a common supply is used.

Power supply impedance is directly in series with the output stage audio signal in a single-ended circuit. Now, in comparison to the several thousand ohms of output transformer impedance and tube plate resistance, a few more ohms in the power supply doesn't sound like a big deal. But if you had, for instance, a brute-force filter with 100 microfarads at the output, the impedance at 20 Hz is about 80 ohms.

Not only does this value vary with frequency but it is probably also nonlinear when electrolytic capacitors are used. Most likely the effects are inaudible and a small film bypass cap across the electrolytic would address any audible problem, but there is another way. The output impedance of a regulated supply can be *as low as you want* and it can be held constant over any reasonable bandwidth.

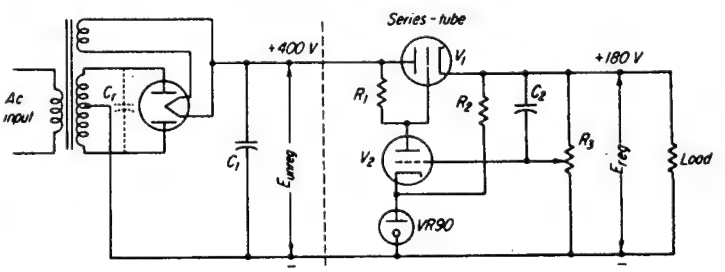
The design of regulated power supplies is far too complex to explain in one magazine article (that is, if I understood it all myself!). And my primary aim is to promote the resurrection of old, already-designed, well built, and available equipment from the 1950s rather than to encourage new designs. However, for those of you unfamiliar with the workings of regulated DC supplies, it may help to think of a regulated supply as a feedback amplifier. Instead of an audio signal, the input is a DC voltage. The output is taken from a cathode follower. If the gain and the bandwidth of the amplifier are high enough, the output impedance will be very low over the entire audio range. Of course, the response must extend down to DC.

Any regulated supply, then, can be divided into four parts:

- An unregulated DC source with minimal filtering.
- A cathode follower whose plate supply is the unregulated source, typically a 6AS7/6080 or paralleled 6L6s.
- A DC amplifier that senses the output, compares it to a stable reference voltage, and drives the cathode follower.
- A stable reference voltage, usually a gas regulator like the 5651. Some older designs which used poorer VR tubes like the OA3 incorporated separate semi-regulated supplies to drive the reference tube.

An understanding of the basic principles should allow you to decipher any circuit you may encounter. Langford-Smith's *Radiotron Designer's Handbook* has a chapter on the subject (with a long bibliography) and Benson's *Voltage Stabilizers* provides still more references.

It is a lot easier to find and restore an existing supply than to assemble components of equal quality and build from scratch. Homemade designs have occasionally appeared in electronics magazines



Schematic of typical vacuum tube series regulated DC supply



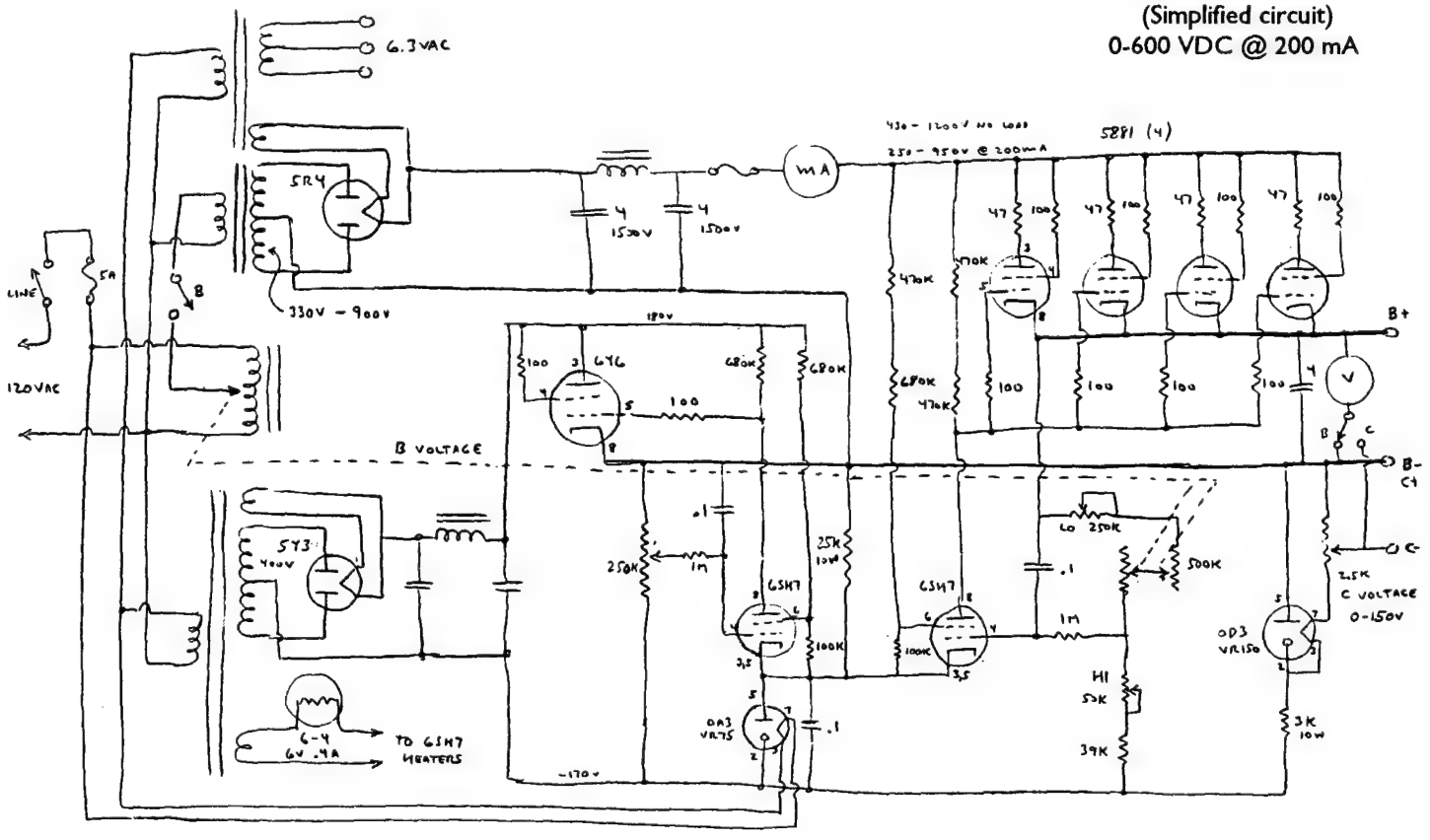
Kepco has been around since 1946—still run by the same Kupferberg family too! I had to trace this circuit of this unit myself (see below) and replace several small paper caps that were leaky. It's BIG, but it works fine.

but the BEST circuits were designed for commercial equipment—either as separate supplies or as integral components of precision instruments.

Power supplies come in two basic types: those that go down to zero volts and those that don't. Those that do were intended for bench use by design engineers or technicians. They usually have voltage and current meters, front panel controls and terminals, 6 VAC heater supplies, and often a separate low current bias supply. Kepco, Hewlett-Packard, and Lambda, among others, made excellent DC supplies or you can take your chances with a popularly priced Heathkit model.

Fixed voltage supplies, intended for powering equipment continuously, are variable over a certain range (set by rear panel controls) but rarely go below 150 Volts. They are usually rack mountable with rear terminals and may or may not have panel meters. The very best were made by Lambda. The Lambdas used hermetically sealed transformers and oil capacitors (no electrolytics at all), and have banks of 6L6s or 6080s as

KEPCO 815
(Simplified circuit)
0-600 VDC @ 200 mA



series-pass tubes (cathode followers). Extensive restoration of Lambdas is not necessary, just check the tubes and plug them in!

Vacuum tube regulated supplies are nowadays a drug on the market and, when you can find them, they will either be cheap or free. Unfortunately they don't often get "drug" to flea markets because of their considerable weight, so you must ask around. Ham flea markets are a good place to look. I got several from my doctor, who hauled them away from a local research establishment some years earlier. Have faith—and the phone number of a good chiropractor!

References

Langford-Smith, *Radiotron Designer's Handbook*, 4th ed.

Benson, *Voltage Stabilizers*, London 1950, 1957.

The author submitted a nice reprint of National Bureau of Standards recommended regulator circuits plus we added a few we dug up ourselves. To get a copy, send $2.50 US/Canada, $4 overseas airmail.



These industrial strength Lambda supplies come in 200, 400, 800, and 1500 mA versions in three voltage ranges: 0-200V, 125-325V, and 325-525V. Voltage is set by toggle switches that select transformer taps; fine adjustment is by external resistors. They are unbelievably rugged, reliable, *and heavy!*

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FEW STONES UNTURNED

A road trip to the state of the art

By Herbert Reichert

The three of us stood looking out of separate windows of my firehouse turned abode. We tried, but were unable to enjoy the beauty of the snowfall making magic of the Manhattan skyline. J.C. looked like a kid who had just crashed his bike. Mike looked concerned.

Then the phone rang. It was the atmosphere scientist telling us that the sky was clear and the roads were dry all the way from White Plains to his house. He also mentioned that the three systems were all gassed up and ready—sitting on the runway, as it were.

The next thing I remember is looking in the rearview mirror. I saw Bruce and Mike in the back seat. Mike appeared to be asleep. Then I noticed the interlocking circles of an Audi grille close up. Strange, one doesn't expect tailgating at 100 m.p.h. I mildly dislike tailgaters. J.C. nodded and smiled so I put Mike's Alfa into fourth and depressed the throttle. Moments later, the tailgater dipped below the horizon like the setting sun.

Thirty minutes down the road, we were crawling around on our hands and knees, turning over amps and fondling solid silver speaker wire. We made it to Arthur's in half the usual time.

We would all have been depressed for two months if we didn't make it to the Professor's house that weekend. Why? Because Dr. Arthur Loesch and his two friends, Bob Cummings and Jon Baier, have three of the most sophisticated, beautiful sounding music reproduction systems in America.

These three men are well known in the audio underground as experienced listeners who have designed and constructed handmade audio systems of the highest caliber. We were looking forward to meeting with them, hearing their systems, talking audio, and gathering the kinds of ideas and inspiration which could follow from such an event.

Some of the side benefits of having "audio friends" are getting to know their record collections and learning to enjoy their system as they themselves do. Because of shared interests, we can actually come to know and understand our audio friends better as people through understanding their music and approach to the art of system organization. An individual's approach to audio communicates a lot about that person to another who understands.

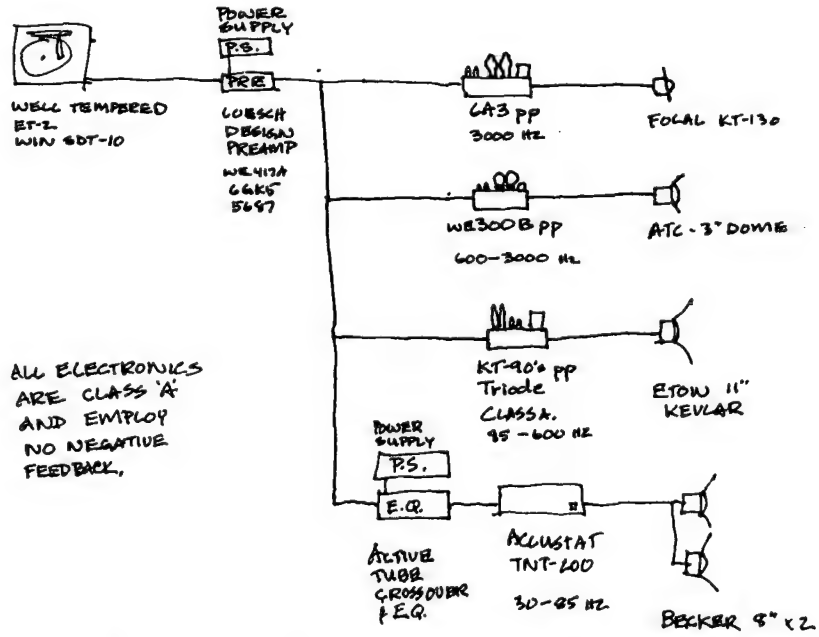
Handmade systems are especially fun and enlightening because they communicate the builder's individuality and distinct view of the art. However, whether the system is hand-crafted or totally store-bought, everyone must select their transducers—and nothing affects the sound of our systems or reflects our personalities more than our choices of speakers and front end components.

Our hosts provided cases in point. Each built his system "to taste" and developed its character through extensive research and experimentation. They are friends and the quality of their systems is raised through an ongoing dialogue involving sharing of discoveries, friendly criticism, and perhaps a touch of competitive spirit. It is a small community of "like minds" with different approaches.

Let's take a tour of each system and meet the artists who constructed them.

BOB'S SYSTEM

Bob Cummings has been listening to quality systems since 1953, starting with an Electro-Voice coaxial in an open-backed Karlson cabinet. He switched to Klipsch horns in 1955. In the 1960s, he put some Hartley 24" drivers in a 14 cu. ft. cabinet and crossed them over to Hartley 10" upper bass units. Midrange was a KEF 5" and so was the tweeter. These were driven by Dyna and Acrosound amps. The 70s brought IMF monitors and Magnaplanars into Bob's home. When I met him in the



Block diagram of Bob Cummings' music lover's system

early 80s, he was using Strathern ribbons, pure triode amps, and a Dynaudio line array as woofers. Just before he set up the system I describe below, he was driving Martin Logan CLSs with push-pull 300B amps and actively equalized subwoofers of his own design.

At Bob's house you are greeted with a warm handshake and the warmest of smiles. As he takes you downstairs, you step into another world. When the music starts in his carefully designed listening room. . .you'll never want to leave. His system has the ability to suspend critical mind functions. All types of music become engaging works of ARTISTS! It's almost hard to think in audiophile terms when listening to Bob's system. Some might criticize the sound saying that it is more beautiful than real life. However, Bob has exquisite taste and it is his greatest asset as a designer. He doesn't focus on the math or engineering but rather on the creation of beauty. Like an artist.

Bob has worked hard to get his room to be an asset to his sound. Linear diffusers, tube traps, and sonic foam are everywhere. The walls are sawtooth patterned with doors that open and close to adjust the sound and provide access to his concealed record collection.

He doesn't have a CD player for the simple reason that he hasn't gotten to that part yet. The same applies to equipment stands (which he just acquired), line conditioners (which I urged him to get), and specialty line cords. What he does have was selected by listening, trial and error, and asking lots of questions.

Starting at the front, Bob uses a Well Tempered table with an Eminent Technology ET-2 arm with a high pressure manifold. He owns several dream cartridges but mostly uses either a Promethian Green or a Win SDT-10. He likes the Win best but feels that the Promethian provides a realistic concentration of energy which he appreciates. He played the Promethian for us. We liked it too.

Phono EQ and gain is provided by an all-tube Arthur Loesch design preamp. This design was legendary back in the 80s and those who built it or heard it often swore that it couldn't be beat. It has two stages of passive EQ and fixed bias (batteries) on two of its three super high transconductance tubes. Each tube has its own B+ supply using chokes and polypropylene caps in this version. Overall, the preamp incorporates twelve separate power supplies and eight transformers!! The tube complement: WE 417A/5842, 6GK5, RCA 5687. Kimber AGSS pure silver wire, non inductive wirewound resistors, and custom teflon and copper foil capacitors are used in the signal path. Similar passive components and design logic are employed in Bob's power amps.

An Acoustat TNT-200 with an all FET front end by Jim Strickland feeds the energy below 85 Hz to a pair of 8" Becker drivers with treated paper cones. An active tube crossover for the low end allows Bob to actively equalize the output for flat in room response to 30 Hz.

In another pair of cabinets, next to the double Beckers, we have the main array. Eleven inch Eton Kevlar drivers present the fundamentals from 85-600Hz. These are driven by push-pull triode connected KT-90s with UTC LS-65 output transformers. High frequencies are generated by a Focal KT-130 crossed over at 3000 Hz by the coupling caps in the push pull 2A3 tweeter amp. This amp, like all others in the system, is bandwidth limited by carefully adjusted interstage R-C filtering. This eliminates the need for additional gain stages or active filtering and provides all the usual advantages of bi-amping. Do not underestimate the importance of this design feature.

I asked Bob what advice he would offer to those assembling high quality systems: "Get the midrange right first and try not to lose it going after the frequency extremes." So what does a man who has listened to a lot of midranges use today? A pro-sound three inch, soft dome by ATC, the SM75-150S. Most designers choose 2" domes for a more present full bodied sound than that provided by typical 3" domes, which can be very recessed. Not this one. This partially horn-loaded driver gives you the bandwidth and air moving qualities of a 3" with even better presence than 2" domes. Bob runs this exotic driver with a push pull Class A WE 300B amp using LS-55 transformers. J.C. thought it was just about the best midrange he had ever heard—he's still talking about it.

All of Bob's amps are Class A designs without negative feedback, using low mu triode drivers (6DJ8, 6SN7) and wide-bandwidth quality vintage iron. Each of the three tube amps per channel has two power transformers: one for the driver stage and one for the output. Counting the preamp, crossover, and FET bass amp, that's THIRTEEN power transformers per channel! The system requires six lengths of interconnect and eight lengths of loudspeaker cable, *all silver*, per channel. Not to mention ten teflon caps and dozens of wirewound resistors per channel. Did I mention the polypropylene caps in the power supply? Whew! Who said avoiding mechanical sound was easy (or free)? You must trust me though; not only was there no mechanical sound, but this conglomeration of metal, teflon, and paper could light up and take you to Carnegie Hall.

This is a short trip and it's getting late, soooo. . . if we can drag ourselves off the sofa and out into the twenty degree weather, we can go over to Jon's for a taste of something simpler.

JON'S SYSTEM

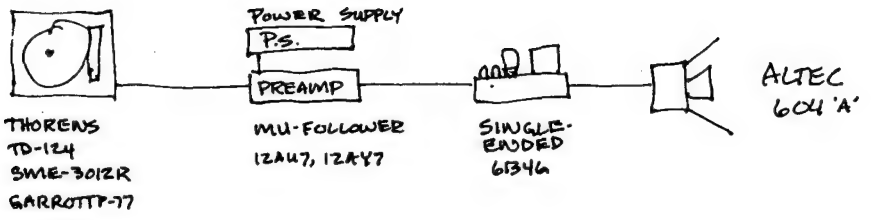
Jon Baier's setup is almost Zen in comparison with Bob's. It has only one amp per channel! Jon has a "to die for" record collection. I always go back to New York and hunt for the records I hear at his house.

I should admit this up front: I may be a poor hi-fi critic because when a system likes a record (plays it well) and I like a record (like the music), then I like the system. The system that likes the most records wins. I can't truly like a component in isolation because it can't play a record in isolation. Jon's system can really play records—lots of them!

Jon usually plays country, blues, rock, or bluegrass when I visit. His 15" Altec 604-B coax speakers are perfect for this type of music. Sometime before this visit, he added some extra baffle area to his homemade bass reflex enclosures to give the lower-mids more body. He also removed the bakelite loading cap on the 604 to cool down the horn a bit. Jon tamed this tricky speaker well.

Several years ago we compared the Thorens TD-124 turntable and the Well tempered in Jon's system. We are both still using the Thorens. He adds a Garrott P-77 cartridge to his SME 3012R arm and connects it to his preamp with homespun shielded silver interconnect.

The preamp is his design using 12AU7s and 12AY7s in a mu follower arrangement. He



Block diagram of Jon Baier's rockin' system

uses separate power transformers and choke input filters (with polypropylene caps) for each tube. Jon says he has tried most everything but settled on the mu follower and low transconductance tubes. Like Bob, he uses teflon caps throughout the signal path. He also likes wirewound resistors best, claiming that they sound the "sweetest."

John is a machinist at heart (and by trade) and his precision metalwork, careful layout and parts mounting, and artful hand-wiring have been an inspiration for my own craft.

In Jon's system, as in each of the systems I describe here, component selection, layout, and craftsmanship are equal in importance to the raw circuits they bring to life. The physical and sonic beauty of this system results from dramatic and effective combinations of old and new: mini-toggles powering up sub mini neon lights and RCA red base tubes connected by gleaming pearl teflon insulated silver wire and teflon caps to vintage black crinkle Jim Lansing speakers. You can't buy this vision at your local "Low-fi Exchange."

The Altec 604s are driven by single-ended 6B4-G triodes which produce three watts. The output transformers are Magnequest FS-030s. They are a ten octave design which works perfectly in a full range application. The driver stage uses red base 5692 tubes in the mu follower configuration. This little "three watter" really loads the room with mike-feed quality sound. Whoever thinks that a flea power single ended amp can't provide convincing bass should hear this setup. The kick drums hurt your chest!

ON TO ARTHUR'S

When I stepped through the door at Arthur's house, he immediately started telling me what he had done to his system and what I should be listening for. I said, "Arthur, why can't we just listen to some records?" He says, "Herb, you didn't drive 100 mph for two hours just to listen to records...you can do that at home!" He is right (as usual), we came to hear THE SYSTEM. Now, it is important to note that Arthur is known by audiophiles and designers as a brilliant man on a mission: to design the best possible music reproduction system—and then improve it. Arthur is always looking, measuring, listening, and asking, "Is there something minor we may have overlooked that might really be important but we just don't know that it is important yet?" This is how a scientist looks at audio. He also reminds me of Edison, who at one point could say only that he knew 10,000 materials which would *not* make a good filament. Arthur has done tireless research in a quest for the perfect gain stage. He claims he has only discovered the limitations of the ones he has tried.

However, his system betrays a preference for very linear, low mu, high transconductance tubes and FETs. Balanced, differential, highly isolated gain stages with passive filtering seen to dominate his designs. Tubes are most often run at low plate voltages with very high plate currents, often exceeding the rated plate dissipation of the tubes. The effect of this strategy is to find the "sweet spot" on the plate curve, the place where the harmonic structure of the distortion products is most attractive to the ear. Most designers choose the absolute lowest distortion point that works with the following stage. This is (usually) the operating point where the second harmonic is lowest. Often this point is unnaturally bright sounding.

Arthur has been a teacher and mentor to many young audio designers. This is his lesson: "Keep an open mind and use the old and new only as far as they serve your purposes."

A lot of what A.L. has learned can be seen in the block diagram of his system. As I describe the hardware that corresponds to the boxes, let me try to relate some of the design principles which shaped his present system.

Arthur keeps a pair of Quad ESLs as a reference but he has tried many high end speakers. Finding a truly outstanding speaker to build a system around is very difficult. There are thousands of designs available, but few are true classics capable of providing long-term satisfaction. The same applies (even more so, perhaps) to front ends. The vast range of choices out there reflects the mediocrity of the field. We must make honest "trust your ears" decisions in these areas.



Photo of Arthur Loesch's modest system

This is where taste comes in. Taste is moral and ethical decision making. Our tastes in music should also be reflected in the transducers we choose. We must prioritize our values and decide accordingly. However, this list of values can only be developed over time by trial and error. I suspect that we actually 'try on' different values until we find some that fit and then arrange them in order of importance. This order can (and does) change.

For instance, we might hear a system that does something we never dreamed possible or maybe never even thought about before the experience. Thereafter, this quality can be added to our list and can we go out and look for components that can bring it to us.

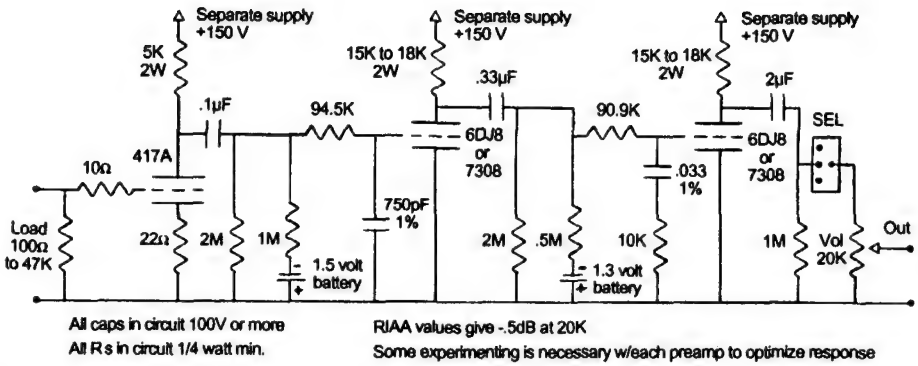
Arthur takes a very specific ethical position in these regards. He is a scientist deep down. He is not a romantic like Bob or a good time, thrill-seeking race car driver like Jon. His criteria for selecting transducers is "Will it follow the signal and add little of its own? Is it compatible with other parts of the system? Will it maintain a consistent level of performance over time? Bottom line: is it accurate?"

His best answer to these questions today includes a Goldring Excel cartridge with a pure silver coil mounted on an ET-2 arm with a high pressure manifold. His turntable is a Linn LP-12.

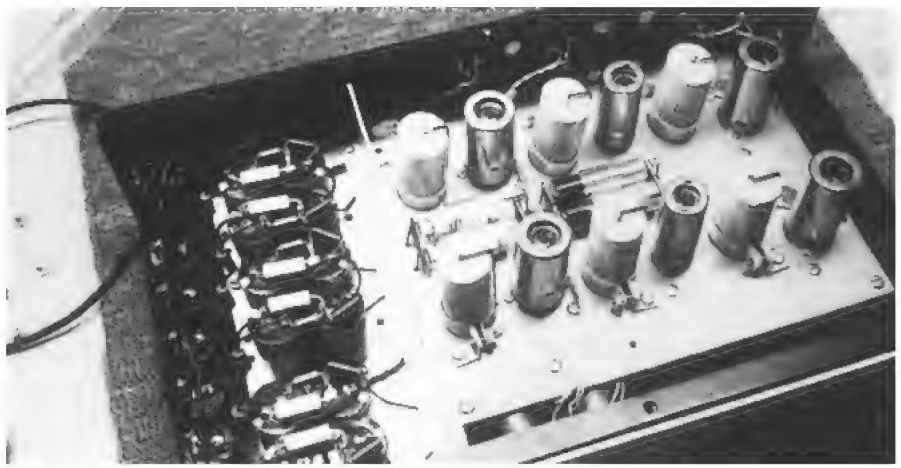
The real creativity and engineering is in the rest of the system. The Focal 122 tweeters are titanium domes with a sputtered oxide coating. They have tuned secondary chambers acting as Helmholtz resonators. Each of the two chambers is approximately 2 cu. in. stuffed with wool. Most of Arthur's guests suggest that the highs are "better than real."

The inverted domes share a recycled SOTA Panorama box with a single Focal 7V. This is a paper cone midrange with glass impregnation and an exponential profile. The Focal 10V617, a 10V with a custom glass impregnated paper cone, is used in a transmission line enclosure for the bass. This combination may not go as low as an IRS-V or a WAMM but it is definitely full range.

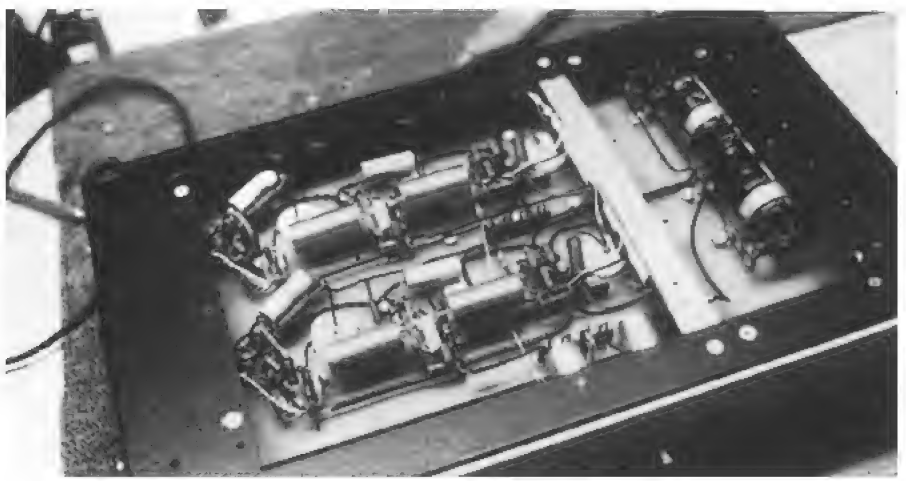
The most unique part of this system is in the finely tuned amplification system. Like Bob's set up, each driver has its own amp. Each amp is optimized to suit the mechanical, electrical, and subjective sonic parameters of its respective speaker. The tweeter is



One version of the 417A preamp. Many experimental versions were built using 6GK5s, 6C4s, 5687s and a wide variety of other tubes in the second and third stages.

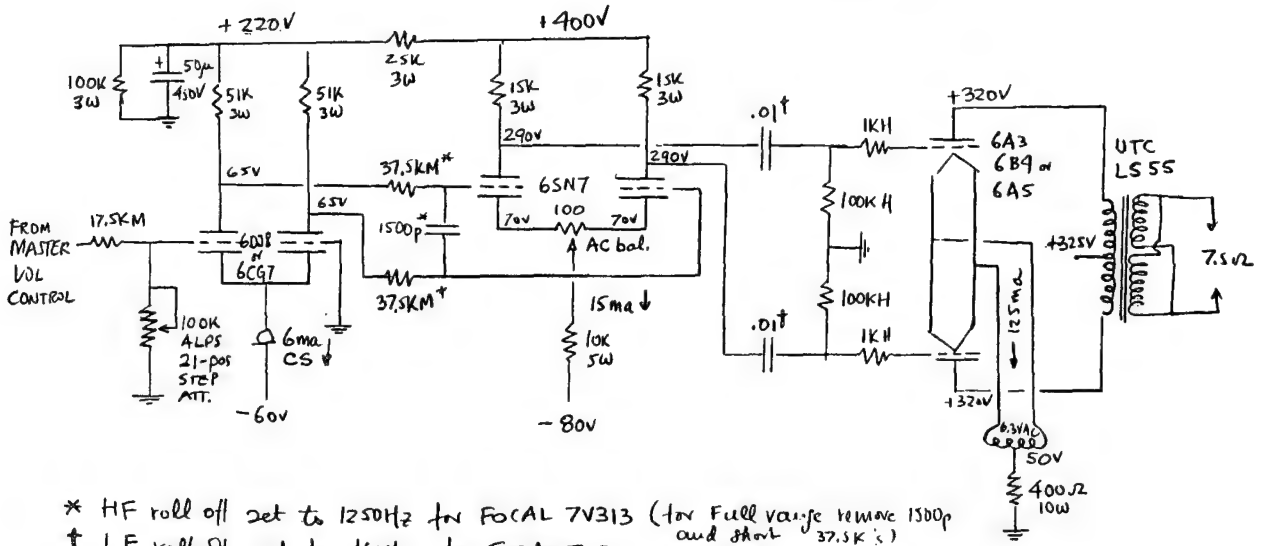


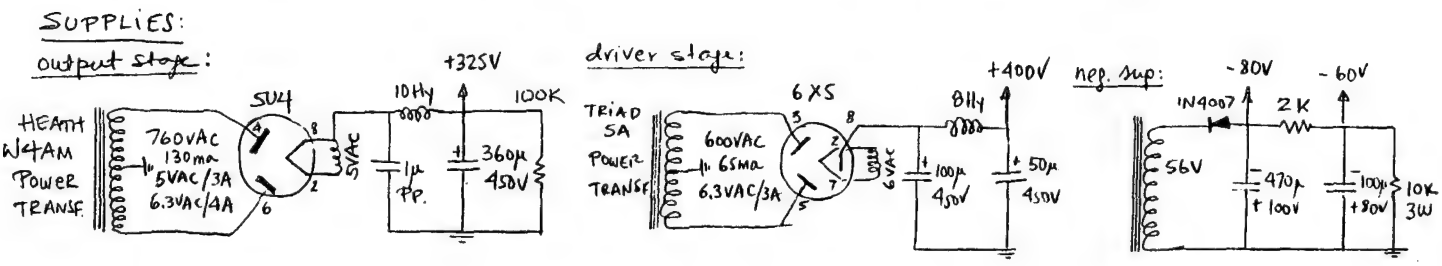
Interior of one version of Arthur's 417A preamp. Note batteries for bias and polypropylene caps for decoupling. Audio circuitry is mounted on a copper ground plane.



Bottom view of Arthur's preamp showing teflon caps, Mills wirewound resistors, and copper ground plane.

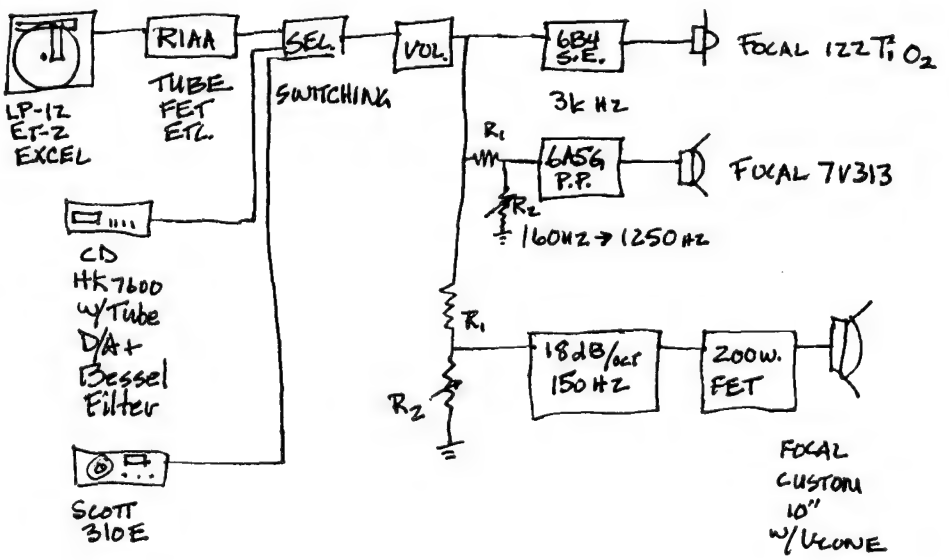
Loesch Audio Design triode amplifier (constructed on Heath W4AM chassis)
Shown bandwidth limited with filters marked * and # to range: 160-1250 Hz





driven by single-ended 6A3 directly heated triodes. This amp uses a Western Electric 348A (like a 6J7) driver tube and Tango FW-20S outputs. Arthur believes that tube amps should be operated in self bias above 150 Hz. Fixed bias subjectively has more punch and authority in the bass but it seems harsher and brighter through the midrange. Self bias also allows for time constant adjustment and bandwidth limiting at the output stage. In these monoblock tweeter amps, the coupling cap between the driver and output stages is chosen for a high pass roll-off at 3000 Hz. Then, more than an octave down, at 1350 Hz, the cathode bypass cap on the input stage rolls the amp off again.

This elegant but simple strategy avoids the dramatic transient and phase shift problems that steep filter slopes can cause and allows for direct connection of amp and speaker. Arthur also provides switchable attenuation at the input of each amp. Driver levels can be set in 1 dB steps. Non inductive wire-wound resistors are used in the attenuators.



Block diagram of Arthur's system

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...a very informal dealer.

The midrange amp operates from 175 to 1250 Hz. Right now, it is a push pull 6A5-G amp using UTC LS-55 outputs with crossovers built into the amps as above. Arthur is planning to replace this amp with a single-ended WE 300B amp. He hopes to gain a little more midrange magic and depth with this change.

There are few "rules" in this sort of exploration and sometimes finding the right amp/speaker combination relies on intuition plus trial and error, regardless of how "scientific" one sets out to be. Clearly, Arthur has discovered that no amp excels subjectively across all ten octaves. Every design favors five octaves or less somewhere in the audio band.

During our visit, we listened to several different amps driving the transmission line bass modules but Arthur's FET design had the beautiful tone of the push pull 6A5s and the weight and punch of a 50 watt bi-polar amp he also designed.

This FET 100-watter is built on an Acoustat TNT-200 chassis and it is direct coupled throughout. The active devices in this amp were selected from about 100 samples, tested for linearity and precisely matched on a curve tracer. Arthur believes that one of the big problems with solid state devices is that sample to sample variation can be enormous. He found that precise matching of components is necessary to get the best sound from transistors. I would really like to hear this FET amp full range.

While he had us as a captive audience, Arthur asked us to offer opinions on three of his designs and compare them to a very expensive commercial product considered state-of-the-art by the audio press. The three home made preamps were original designs: one all tube, one all FET, and one hybrid. All were silver wired throughout, using custom teflon and copper foil caps, polypropylene filter caps, precisely matched active devices, and super short signal paths. Each piece spent hundreds of hours in front of a scope, spectrum analyzer, and a curve tracer. Each had made the trip from the listening room to the bench dozens of times. This sort of tedious work goes beyond anything we could reasonably expect from a manufacturer but the results plainly demonstrate the value of this sort of perfectionism.

Everybody liked the FET-tube combo, it was like the good porridge—just right. It had thrills and magic but, personally, I preferred the more intense magic of the all tube WE 417A based preamp. Vividness is high on my list of sonic values and Arthur's all-tube pre is vivid and Cinemascope like a 50's movie.

Whatever phono stage you like is connected to a passive volume control followed by a "black box" tube gain stage. There is also an active crossover for the bass. This building block approach makes for LOTS of interconnect, speaker wire, and connectors but it facilitates system upgrades and experimentation. The exclusive use of silver wire and custom silver connectors minimizes the sonic damage this complex arrangement might otherwise cause.

I'm sure I sound like a broken record on this parts stuff, but I suspect that readers who have not experimented with this level of parts quality could easily underestimate its importance. Hiroyasu Kondo still remembers his "deep emotion" when he first listened to an amplifier using silver leaf condenser.

The most valuable lesson we can learn from these three very ambitious and industrious audiophiles is to look at every aspect of the audio chain. Build and listen, then listen some more, then build some more, until your tastes and feelings come into focus. No one can stop us from becoming Tom Edison in the privacy of our homes. Soon you can know ten amps which don't sound right with your Sacred Veil speakers. This is real progress. Someday, music will play in your listening room to goosebumps and tear stained cheeks.

On the way home, all "the high fever guys" were either asleep or lost in dreams about how to improve their hi-fi. J.C. (whose system is a lot like Arthur's) said he thought Arthur had "done it all." Mike thought Jon had used his transformers to create a really "deep" amplifier to power the "best of the three." I had to admit that Bob's system "stole my heart." That makes Bruce the tie breaker. His mono horn system is powered by a SE 10Y amp with a silver ingot for the ground plane. That makes him a neutral fourth vote. He said, "Bob's system stole my heart, but Arthur's system captured my mind."

An excerpt from

The Search for Musical Ecstasy

by Harvey Rosenberg

All of our searching, in whatever form it takes, is full of our humanity. Our predatory/competitive, testosterone based biology is fully active even in our most subtle and profound yearnings. The Greek Gods were constantly feuding for position and all the world's mythology is filled with violence and the struggle of the Gods to be dominant.

Questions of hierarchy are inevitable. Who is the high priest of audio? Who has the best audio system? This is not a bad thing. Let me share with you how I was blessed with discovering the world's best sound system.

I heard this system after I had already become a serious audiophile, but not yet a manufacturer. At this time I earned a great deal of money as a design consultant to America's chemical companies, i.e. Celanese, du Pont, Allied Chemical, and Monsanto, all of which have synthetic fiber divisions. I was an expert on fiber and textile design and it was my job to travel to Europe three or four times a year and report back what textile designs were emerging in Europe that would affect the American market. It was during a trip to Paris that I discovered the system, which became the benchmark home music system and had such a profound effect on me it has acted as a compass through the great audio technology storm—always kindling in me the desire to reproduce that ideal experience. This adventure will also give you insight into my peculiar attitude toward the gestalt of listening to music in the home.

The autumn in France is a special gift: the light, the air, and the aromas of the harvest. There is one compelling reason to go to Paris in October—the cooking reaches a level of sensual excitement that must be rooted in the culinary power of a new harvest and the new wine. Have you ever drunk a few bottles of Beaujolais Nouveau sitting at a small Montmartre cafe watching exquisite French women pass by?

It was during the French autumn that I made the acquaintance of the Contessa de St. Lyon, who had started out life as Rhoda Marcus—a nice Jewish girl from Brooklyn who had the good sense on a ski vacation to fall in love with a Count. The Countess had a good life. An apartment in Paris, a "country home" outside of Paris, and a home in Corsica made life bearable.

Generally speaking, I love France but dislike the French. I find them vain, pompous, nasty, and disdainful of foreigners. Plus I'm jealous of them. A nice Jewish girl from Brooklyn who happened to be an awesomely whimsical, charming, and relaxed real live French Countess was an unbeatable combination for this searching Semitic audiophile.

While having dinner with the Count and the Countess at their 20 room Paris apartment (which again confirmed for me that the French have developed the art of eating to a level of refinement that is beyond the imaginative capacity of primitive Americans) the Count inquired about my interest in music. This lead to an invitation to listen to his sound system, which he assured me would be the finest I had ever heard. Now I knew the Count was not into tube electronics and from my discussion he seemed to be from the Bang and Olufsen school of audio wimps, but every diehard audiophile loves a challenge. Why should the French care about the liquid midrange when they had so many other profound forms of liquidity at their disposal.

Throughout this discussion Rhoda just smirked.

I was invited to spend the weekend with the Count and Countess at their country home to check out the sound system. I was excited because I knew I could give him very scholarly advice on how to improve it. The whole family piled into the Citroen, a favorite car of the French, which proves beyond the shadow of doubt that they are totally out in left field.

Quite frankly I was impressed when we turned off the highway and saw before us a very large house, which appeared to be a mid-eighteenth century home with about 20 rooms. It was the gate house. A mile down a majestic poplar lined road we began to approach the cozy little cabin that was the country home. It looked like an Air France poster. Get this: when we pulled up to the Chateau's front door all the servants were lined up wearing white and black striped aprons! This Chateau had been in the family since the 1600s. I don't know about you, but around that time my relatives were living in a cave eating earthworms and spending rollicking evenings pounding stones together to keep the demons away.

What really pisses me off about this type of old European wealth is that it is so refined. Can you imagine a living room that is filled with masterpieces of art, fine furniture, fireplaces and is large enough to hold a basketball court?

Lunch was served in the backyard overlooking a swan filled lake and the newly harvested fields. A long table was set with a peasant-type lunch—fresh baked breads, cold chicken and meat, salads, pates, mousses, fresh fruit, cheese, superb wine and water served in an old clay jug that had a date inscribed of 1722. Water had been served from this jug since that time. Mr. Piggy the Gizmo had a fine time eating too much of everything.

Lollygagging after lunch in the sparkling autumn air consisted of small talk and the unmitigated joy of harvest fragrances. There is poetry in the French countryside that I have not heard in any other place. Quite frankly I had overstuffed myself during lunch and asked how I could find the bathroom. When I turned the beautiful porcelain handle I was certain I had lost my way because I had just entered a small drawing room and not a bathroom. I wove my way back to the kitchen and asked one of the servants how I could find the bathroom. I was led back to the same room and was shown the potty.

This was the most intimidating bathroom I had ever experienced. The potty was hand painted with scenes of cherubs. The toilet seat was also hand painted with flowers and running deer, circa 1700. Let me try to use an analogy to describe my discomfort. Can you imagine sitting down on a toilet in the main picture gallery of your local museum, one whose floors were covered in rare Persian carpets? I was raised and am comfortable in your basic American bathroom, and felt that any minute a crowd of Japanese tourists would barge into the room and start taking pictures of me.

After a walk around the estate I reminded the Count about the audio system demonstration he had promised me. I simply couldn't imagine what kind of equipment he had that was going to blow me away, but after my experience in the bathroom I was looking forward to something very unusual . . . maybe original McIntosh tube gear.

At about seven o'clock the Count invited us to follow him. We passed through the living room into a 40 X 40 room that was empty but for six high backed chairs, three dining room chairs, and a dozen man-sized candelabra. The windows were open and the white lace drapes were gently blowing. Sitting in my chair I could watch the sun slowly setting on the lakes filled with swans. The air was sweetened by the heavy night fragrances of grass and hay which mingled with the breath of the lake. Because there was no audio equipment or speakers visible I expected the Count to whip out this B&O remote control and demonstrate that he had fourteen thousand small speakers hidden in his ceiling. He left the room, and a servant came in with a tray and served us brandy from a beautiful cut crystal decanter. After we were served all of the candles were lit and the electric lights turned off. I was so delighted to be sitting in his magnificent room, sipping brandy by candlelight while the French perfumed harvest was intoxicating me that I didn't care about the possibility that the Count's system would be a musical flop. I would be kind and understanding as a way of showing my gratitude and that I was not a completely boorish Americano capitalist pig.

A trio of tuxedoed musicians walked in with the Count leading the way. He introduced them as "the finest audio system in the world." Who says people with money can't have fun? I was being treated to the same sound system that Louis I listened to. I was being treated to the sound system that this dickhead of a Count grew up with. I lost the bet.

Sitting in that room and experiencing chamber music in the context for which it was designed was a revelation. The performance was not great. I had heard the best world class chamber trios in New York City. There were parts of the performance that were downright funky, but it was still the most ecstatic performance I have ever experienced. The Count was right.

Have you ever wondered what it was like to be alive during the time of Moses, Jesus Christ, the American Revolution, or what it was like to hear Bach or Beethoven play? I was truly in a time warp. It didn't matter that the playing wasn't the finest I had ever heard. I had forgotten the importance of the context in which we experience music. I had forgotten how deeply affected composers are by the gestalt of their composing. I had forgotten how modern music listening had traveled so far from the warmth and intimacy that is the foundation of our musical roots. This was the proper way, the proper context in which to experience music in the home. Reproducing this experience in the average suburban home must be the goal of every audio engineer.

And therein lies the fundamental aesthetic error that the audio industry keeps on repeating. Yes, audio equipment is important, but the listener's state of being and musical context is just as important. Every instruction manual of every piece of equipment should contain a reminder of how important it is to create a home musical environment which supports the listener's emotional vulnerability that is a precondition for escalating our search for musical ecstasy.

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Harvey Rosenberg's book, *The Search for Musical Ecstasy*, will be available June 1993 from Sound Designs, 1242 Fascination Circle, El Sobrante, CA 94803.

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FORGETABOUT AMPS!

by Vincent Gallo

The Gallo of Vinny Gallo's "Mono Mia" Fame

I just finished reading a copy of the famous new magazine *Sound Practices* Number 2. I got my copy yesterday, the same day my agent informed me that I brown nosed myself another job acting in a Hollywood movie. She told me I was cast along with Jeremy Irons, Meryl Streep, Glen Close, and Wynona Rider—so I figured I deserved MILLIONS. I had to spend the whole day on the phone with my agent and their lawyer. I told them The Gallo doesn't work for less than a million a film. They offered 10,000. I took 15 K—that's $2,985,000 less than each of the other actors was getting. With all this Hollywood-style schmoozing to do, I couldn't just relax and sit around reading my new SP #2.

The thing is that as soon as I got the job I started to worry. I've worked as an actor for 12 years but I still get it in my mind that I don't know what the hell I'm doing, and I probably don't. I always imagine all the other actors are going to think that I stink and that they will hate me. So I begin hating myself, a little more than usual. I start to feel like I deserved the ten thousand beatings I got from my father and that my mother was right when she said that I wasn't at all handsome enough to be an actor and that I should learn a trade instead, maybe plumbing.

I looked into the mirror. Ohmygod, she was right. I hate my greasy guinea skin, I hate my hair, my big ugly nose. I started feeling like the talentless greasy, slimy little piece of shit that I am. However, in the past I worked with some big stars like Faye Dunaway, Robert De Niro, Jerry Lewis, Johnny Depp and other jerks like that. None of them were intimidating to work with and usually within minutes of starting a new film, I can slip back into my judgemental arrogant cocky self. THANK GOD!

Unfortunately, shooting wouldn't begin for 28 days so I had 28 days of rampant self disgust and giant fears ahead of me. Audio was the last thing on my mind. Sad because my usual neurotic obsession with Hi-Fi helps me kill some of my spare time. Maybe I should get a friend? Anyway, why wasn't I out with some chick celebrating? Why can't I enjoy the whole thing instead of worrying over and over about how much Meryl Streep will hate me?

Anyway, that night I couldn't close my eyes. I flipped on the light and began reading Number 2 to take my mind off Meryl Streep. Suddenly, a miracle! I fell into a deep, deep sleep—deeper than I have ever known. You see, Sound Practices #2 was so boring and dull that it put me out like a light. Thank God for Number 2 and thanks to all you unemployed clowns for those rehashed schematics. Otherwise, I wouldn't have slept for 28 days without the help of a cheap hooker or some big pills.

Yeah, Number 2 was a real snoozer. Number 1 with MY classic article on Mono was much better. Could you believe that Joe Roberts wrote an article on that $60,000 Ongaku amp? For all of you who don't know this, Joe Roberts is the cheapest, penny pinchin', food stampin', pricetag switchin', welfare check cashin', pull out your teeth and nickel and dime you to death Hi-Fi nut in America. If Joe can't trade even for something he found in a dumpster, or buy it outright for a penny, then it just don't go home with Joe. I mean the guy is too cheap to do a glossy cover for the magazine, but he will use up column space to write about a $60,000 amp he never listened to.

Joe, you bottom trawler, you cheap Bacalao, you cheap chiseler, how dare you alienate the working man!!! You have one claim to fame—you are the king of great Hi-Fi sound for under a buck. If you're too cheap to buy it, Joe, don't write about it. Leave the *Ongaku* column for *The Absolute Sound* so all those jerks can go trade in their Cello and Krell junk for it.

Joyce is my favorite writer so I read the magazine starting from the back, Japanese style. Herb Reichert's article was next and not bad either. Herb is sentimental with techno wiz thrown in. His article shed some new light on my childhood memory of the first time I hooked up my Marantz Model 2s in triode; Yes, yes, they did sound a little better—but not by that much. The second I tasted one sip of real triodes (WE 43 with 211 tubes) I shipped those beautiful brown Model 2s off to some brownholed neurotic Marantz collector who had me on the phone for hours discussing the condition of the power cord. I had to guesstimate the number of times it was plugged in and pulled out. The Bastard.

I had to deal with him though because the Japanese would only buy the big overpriced shitty sounding Model 9s. So much for the Japanese paying the most for the best sound. I can still hear echoes of Japanese accents asking for Model 9s. Model 9s stink, period.

Anyway, by the time I read through to the thorazine laced column "Art at the Edge of Science," I was sick of amps and amp talk. It's the same old Audiophile bull crapola—amps, amps, amps, this amp design, that amp design, bigger, fatter, more this, more that, and more and more expensive. Too much amp talk. You're giving me adjida. What about horns, drivers, crossovers, preamps, phono sections, cartridges, records, speaker box design? How about classic turntables and arms, huh? How about some tape machine talk? Listen, you brown stained techno macho audio drag queen fairies, enough is enough!!! Ya hear me?

Amps are not that interesting to talk about; they don't make or break your system by themselves, and choosing an amp is a relatively easy thing to do. So stop aggravating yourself 'cause I'm gonna make the choice simple for you, but I'm gonna tell you just one time, and after this I don't want to hear the word "amp" again, Capisci?

PENTODE - Thank God for pentode amps otherwise you *big cornholes* wouldn't have all that big POWER pentodes were designed to give you, so all you retards could drive your inefficient speakers. Now, I have actually liked a few inefficient speakers in my life. I said *liked* not loved—DQ-10s weren't bad, my classic AR-1 with Janszen tweeter setup was good for a few records, but they are all very forgettable. All the GREAT speakers I've heard we're ultra efficient so to compromise amp sound quality for high power design fundamentally makes no sense.

However, if you must have or are stuck with inefficient speakers (or speaker if you're hip enough to be in mono), there are a few good ones to choose from. If you like brown (and I do love brown), the Marantz Model 2 is neat. The Western Electric 142A is good. But the best pentode amp I've heard is the WE 124C—the early silver ones (not the gray) with the engraved (not ink stamped) number 171C transformers. They are pretty good and I really loved mine but I yelled out "YES" in two seconds when my idol Walt Bender asked to buy them from me. I think he still uses them. He has some of the best ears on the planet (and his checks always clear). So the silver 124s can't be all that bad.

OTLs - I listened to every Futterman piece, the Atmospheres, a home brew 6336 amp, and an 80s German thing called a Diffenbacher. They all give me an image of what it would be like to drive a car with a 64 cylinder engine. Most are below average. The best OTLs are not bad but they are usually expensive and need frequent adjustment. And for what? You only get "not bad." Big deal. I say OTL, schmo-TL.

SOLID STATE - I don't want to be heavy handed and declare that all solid state amps suck. But I have no choice because they do all suck. They are over priced, over designed, unreliable, hard to fix, age horribly, and never not in a billion trillion years will they sound as good as the best tube stuff. Although, if you're into the whole grunge look 70's thing, get yourself a polyester shirt and go out and hunt down a big bad SAE, or a Son of Ampzilla, or a really not too bad Bedini 10/10.

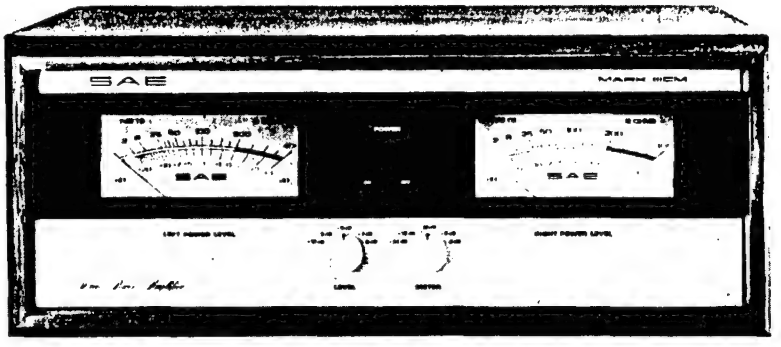
HYBRID - Ha, HA , HA
1/2 tube, 1/2 solid state. This here nor there sensibility doesn't appeal to me. It's mediocre thinking. It's a half-assed compromise. Just say NO!

TRIODES - Ahhh, Triodes. Che bella, triodes. Wonderful, wonderful triodes. Beautiful triodes. Okay, you get the point, they're simple and they sound great. Choosing a triode amp will let you forget about the amp part of your system. All you basically need to know is that the tube type and the output transformer are mostly responsible for the sound. But here are some tips anyway since I know you all really need to obsess on amps . . .

First, you have to choose between push pull and single ended. Both types can sound great. Since the SE types only use one tube they are simpler but usually are very low output. They only work well with real efficient speakers—100 dB/W and up. They absolutely GLOW when hooked up to horns. It's shocking how good they can sound.

My absolute favorite factory builts are the WE 91As (see SP #1). They are super good looking but they usually need some work to get set up and running quietly. All I can say technically is that I had better luck using single ended types without feedback. I took the feedback out of my 91s. Unfortunately 91s are expensive, hard to find, and hard to match up. So maybe this is the "mono moment". . .

Push pull triode amps sound great too. They will give you a little more power without sacrificing sound like the pentode. This extra crumb of power can broaden your speaker choices. I love my WE 86C amps. To my ears, these amps make more speakers sound good than any other amp. They can bring an average speaker to life.



SAE. . .70's GRUNGE CLASSIC

Another way to go is to buy a pair of Magnequest transformers and build a pair of amps or get someone to do it for you. I've heard Mike's latest transformers and they are untouchable, maybe as good as the WE 171A from the 91. Can't believe you did it, Mike. Good work. Anyway, here's a chance for good sound a heck of a lot cheaper than the 91s. If you really want to save money use 6A3 tubes. In my 91s they sound as good as 300Bs. So all you cut throat, price bumping scumbags trying to hawk me your trashpicked 300Bs for top dollar, think again. Even in Japan, you can buy late 300Bs for $275. Actually, WE tubes don't necessarily sound better than other companies' versions of the same tube type, especially the rectifiers. They are only cool to have if you own the original WE amps and you are anal about things—like me and the Japanese. The tubes used in the popular WE amps go for big bucks. Don't build around them. If you're really into Western tubes, try the odd numbers like the 275. Use whatever is cheap and available. By the way, the Chinese 300B copies are not bad at all.

So the word from the Gallo is just get a triode amp, any triode amp. Shoot for WE 91s or 86s if you're into classics. Or buy some transformers and get some amps built. Or talk to Don Garber or J.C. Morrison at Fi in NYC. They understand. There are a million tubes to try like 10s, 50s, and all the 2A3 family. Just do it and forget about it. Worry about the rest of the system. Move on to the fun stuff.

Alright, to get a discussion on speakers underway, I figured I'd throw you cheap lazy Hi-Fi nuts a bone. I, Vinny Gallo, that's right, The Gallo. Me—Vinny G, Vincent Gallo spent $96,329 dollars, drove over 16,238 miles, and yapped on the phone for hours to chisel away gear from some of the biggest bunch of money grubbing, Hi-Fi pimpin', mis-representing, slick, conniving, back stabbing, solid state listening Hi-Fi dealing jerks in the USA just so I could generate some interest and discussion on ANYTHING BUT AMPS.

I managed to collect Western Electric 12A, 13A, 15A, 16A, 22A, 24A/B, 25A/B, and 26 horns. I'll be listening to these with 555, 555W, 594, and 713C drivers and 596 and 597 tweeters. I plan to set these up in a huge loft in Soho, NYC. Me and my super pal Mark Lyons will sit there like two big assholes for hours listening and A/Bing while all you Hi-Fi pimps are sitting around watching prime-time TV and eating chips while waiting for the phone to ring so you could make another quick buck selling off some antique gear you finagled off some blind widows. That's right Rick, Larry, Vernon, Scott, Sumner, Hitochi and Joel. Stay tuned for #4.

Chew the fat, shoot the breeze, mull it over, think about it, and please, please forgetabout amps. Love, Vincent.



OPEN LETTER TO TUBE MAKERS: LET'S DEVELOP A MODERN LOW MU TRIODE!

Although the Western Electric 300B is indeed a superb tube, it can be used in home amplifiers only by the fortunate few who can afford them. Small production quantities prohibit economical manufacture so the price is a very high $200 per tube. Other practical drawbacks of the 300B include its obsolete 4 pin base, an unusual 5V filament supply requirement, and a rather low mu which makes the tube somewhat difficult to drive with low distortion unless an expensive interstage/ driver transformer is used.

OK, so large scale production of the original WE 300B is gone. Well, let's develop a modern low mu power triode for the audio amplifier mass market. It could have an octal base, a 6.3 V heater, a 50 watt plate dissipation, a maximum rated plate voltage of 600V, a cathode, a mu of about 8, a plate resistance of about 700 ohms, and be pin compatible (minus the screen grid) with a 6550 or KT-88.

This new tube could be used to upgrade ultralinear 6550 or KT-88 amplifiers to triode operation without any wiring changes. The potential market for such a tube could be enormous. The availability of such a tube is long overdue.

The new tube should be a genuine triode and not a modified 6550 or KT-88 with the screen grid connected to the plate inside the tube. When a "triode connected" pentode is used, the electrons arrive at the plate a short time after the electrons arrive at the screen grid. The difference in arrival times results in a type of phase distortion or signal "clutter". The signal current which flows in the primary of the audio output transformer thus consists of two components which are slightly out of phase with each other. This is a little-known effect which should explain why amplifiers which use "real" triodes sound better than amplifiers using "triode connected" pentodes.

Hey, tube manufacturers! Are you paying attention? Maybe a smaller version of the new tube could also be developed to upgrade 6L6GC and 6CA7/EL-34 pentode amps to triode operation?

Ed Warden
Lynchburg, VA

SEMPER FI

Dear Mr. Roberts-san:

I must respectfully decline to agree with the thesis of superiority of single-ended triode amps, horn speakers, and most all of the other affectations of the Japanese audiogerontophiles now coming to American notice.

If you will recall, either firsthand or from the now-musty books from the old days, the High Fidelity movement started in large part as a rejection of those big chunks of furniture called "hi-fi's" sold in very large number from just before the Hitler war until the early seventies. They were a symbol of all that was evil about consumer culture, because they were expensive, sold by commission salesmen to non-technical people, and were by no means any technical achievement to be proud of.

Sonically, they were considered evil. They had extremely truncated bass response because, in addition to having cheap transformers, the speakers were mounted in the same cabinet as the diecast aluminum record changer and any substantial bass would have meant the unit would have groaned with feedback until it disintegrated. The power output was inadequate, the speakers were trash, stereo separation was poor and in general they were lousy. They were, in a word, low fidelity.

However, they were very popular and sold well. In the early sixties, a first-rate component system could have been had for less than many of these blond monsters. Aside from their value as furniture and the fact that the buyer had no need to connect or fool with anything, it was also a fact that many buyers actually preferred the sound of these units to true hi-fi. They were "rounder", "mellower", and therefore "more musical". Salesmen of the period (and I can remember it well, because I used to badger them) played this up to no end and the buyers indeed loved it.

Changing musical tastes and the Japanese solid state invasion put the big console out to pasture. Within a couple of years, the average consumer was going down to CMC or such like and buying component systems offering measured performance bettering anything the "stereo nuts" had access to in their day. The so-called High End started up shortly thereafter. Its premise was that equipment could measure well and still sound lousy, and that listening to it was the way to sort the wheat from chaff. However, they did make explicit that the goal was reproduction of music, preferably accurately actual recordings of real music (i.e. music performed in real time in a finite space in air as a listener would hear).

To do this, you still had to have certain objective absolutes. You needed amplifiers with the full audio bandwidth, and enough power to provide the requisite headroom so as to never clip the signal. You also had to have speakers with flat, wide response and the capability of handling the excursions of the dynamic range of music. Real music, not some stuff by opiated English layabouts passed through the bowels of Teletronix limiters and Fairchild compressors and Pultec EQ boxes (all worth their weight in Marantz 7s and 9s and 10Bs several times over, alas...).

Now that this idea has, egads, become popular and accepted, as it has because, magic wire and Tice clocks and Peter Belt and Armor All aside, it had merit; you could, and many did, make good-measuring stuff that sounded rotten. (Say "hi" to those nice folks in Binghamton...). Some have a driving need to be more different and esoteric. The same people who used to do things like put Lycoming aircraft engines in Volkswagens have discovered that you can make audio gear out of huge transmitting tubes and other neat-looking industrial junk.

Of course, when the basic lessons of fidelity in audio have to be stepped on a little, we just say that it's better this way. We like the round mellow sound of deficient bass and we like the harmonic flavoring of a little distortion. And if the resulting "system" of surplus high-school-gym speakers, amplifiers that look like something from a bad sci-fi movie of 1959, and a turntable out of an old Jeezus Saves!!! country gospel radio station perform pretty much like those old bleach-blonde squawkers, who cares.

I admire your publication for its do-it-yourself spirit and its willingness to point out some of the old High End's follies. But I think once you depart from the true quest of fidelity, and I think 99% of the

triodephiles have, you wind up where we started pretty quick.

True fidelity, in a musical system or anywhere, is not always pleasant. A less-than-musical recording must come out that way, if the "fi" really is "hi". What the mega-yen Japanese systems, the old blond bombers, (I'm trying real hard not to make any remarks here about a certain female singer from Hawthorne, NJ...) and for that matter an old Rheem Califone AV gramophone plugged into a pair of Fender Tremoluxes have in common, is that the fidelity is deliberately sacrificed for a sound the listener likes better than reality.

Where does it end up? Eventually, once detached from reality, the music system becomes a maze of studio effects boxes, gimmick speakers (Leslies, anyone?) and other outlandishments. I reject this approach and all its empty promises and all its false works. Give me the truth.

Frank O'Connell
Lenexa, KS

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Dear Mr. O'Connell-san:

After all these years of great minds working to perfect the fidelity of reproduction systems, if you want *truth* you still have to go to a concert. Hi-Fi is always a LIE. It's reproduction not production. Detachment from reality happened at the moment of recording.

In our culture there is a strong tendency to equate "old" technology with junk. Indeed, astonishing progress has been made in many technological areas. But if you look hard, you will find approaches that were abandoned on the grounds of economics, inefficiency, and other non-performance criteria. This is the story of the high quality triode amplifier, the Alnico speaker, and many bygone audio favorites. On the other hand, junk is junk regardless of its birthdate. So, among the "basic lessons of fidelity," I would include the truism that the chronological age of a technology is not a strict measure of its sonic merit.

The March issue of *Hi-Fi World* measured the Audion Silver Nights, zero feedback single ended parallel 300B amps, at 0.2% distortion at 1 watt, 1% at 8 W, and 4% at 18W full output. Bandwidth was 30-30KHz. Modest but entirely respectable specs in the real world. A product like this, built with quality and performance in mind, is capable of stunning fidelity. It does the things that the "high end" types love exceptionally well. Sometimes, "more musical" means just what it says.

As the reviewer of the Silver Nights put it, "I've seldom heard recorded ambience so tangible, the feel of a hall or studio so clearly pictured." He reported that textures were "...coming through with an accuracy that is unhappily rare..." and that these amps serve to "...make music gloriously real, to endow recordings with that extra dimension that has no-one doubting the living, breathing performer between the loudspeakers." Is this fidelity, or what?

He reports that the 300B SE did NOT perform credibly in the bass with his Quads. But, for a variety of boring technical reasons, SE triode amps can and should produce great bass—when the speaker/amp combo is right, not always a simple challenge with a ten watt amp if you're looking for a modern store bought speaker. By the way, an April '93 HFN&RR review of this same amp noted that this amp could put out a 28 Hz note "with terrifying effortlessness. Not just the note, but all its weight and power, too."

I consider the ability of triode amps to make less than perfect recordings listenable a real plus, not a fault. For instance, I like 50's Cuban music and I can't find any audiophile pressings of Orquestra Chappotin. Frankly, Chappotin still doesn't sound too good with triodes, but at least my ears don't bleed when I turn it up. Great recordings sound great, as one would expect. In short, a good triode amp, like any good amp, doesn't sound like much at all. The syrupy, slow, gluey mess that I half expected to hear (based on preconceptions) before I built my first SE triode just ain't there.

People who listen to triode amps and some of the classier vintage equipment are usually not newcomers to the serious pursuit of good sound reproduction. You don't ask Mom for an 845 amp when you graduate from high school. Most "triodephiles" have owned more "high end" equipment than they care to admit or remember. They're not trading in their Krells and ARCs for Blonde 1962 Magnavox console "Hi-Fi" sets. Neither are they trading in their ability to hear for a 90 pound amp guaranteed to alienate the local spouse. Typically, "conversion" is based on perceived sonic merit.

Accordingly, when somebody who once owned a VPI with a Graham arm tells me that a 30 year old Thorens TD-124 with an Ortofon RMG309 arm/SPU cart (a radio station favorite) sounds great, I take that assessment very seriously.

Often the products of before-the-fact reasoning crumble when the ear is called in to decide. The only way to judge audio is by listening. Sometimes listening based evaluations seem to suggest that everything we know is wrong. Much of it is. Why should hi-fi be different from the rest of human experience? In this crazy pursuit, you can't simply postulate, you've got to listen.

And *then* choose what you like. Why not? The other options are 1) choose what you *don't* like, or 2) choose what *somebody else* likes. The fact that one "likes" a certain sound doesn't necessarily imply that fidelity is sacrificed. Might even imply good taste.

Many sincerely like the currently fashionable sounds and surely some would honestly prefer the typical audio salon thing to triodes and "old gym speakers." But if you

flatly rule it out instead of checking it out, how can you know whether you're missing out? True, most ancient products and technologies deserve obsolescence—but let's not throw out the good with the bad.

DAMPING

After designing several zero feedback single-ended triode tube amplifiers, I would like to offer an additional reason why they sound different than push-pull amplifiers: damping factor. For a given tube, the damping factor is generally four times greater in SE configuration than in PP!

To get an idea of the damping factor in PP, look at the ratio of the tube's plate impedance to the load impedance. The ratio for PP 2A3s or 300Bs with a 3K plate-to-plate load is about 1 (each tube sees 1/4 the plate-to-plate impedance). The ratio for a SE 2A3 with a typical load (2500 ohms) is around 3. You bet you'll hear a difference! For example, into a typical electrostatic speaker, an amplifier with a damping factor of 1 will roll off the high frequencies above 10KHz. Damping factor is defined as the ratio of load impedance to source impedance.

The output of an amplifier with a high output impedance/poor damping factor will follow the speakers impedance curve. Since most dynamic speakers have a rising impedance in the bass and mid to lower treble regions, these frequencies will be boosted. Voila, an audiophile tone control. Sure, the response was flat into a resistor. Negative feedback can be used to reduce the amplifiers output impedance and minimize this effect. A high output impedance will also effect the transient response of closed box woofers which can make the bass sound muddy.

SE pentodes have a very high output impedance. Gordon Rankin's design in *SP* #2 claimed 1.16 ohms output impedance (a damping factor of about 8 referenced to the 8 ohm tap). This is way off! The ratio for an 807 is about 38K to 6K, or 0.16. As an approximation, the output impedance will be 50 ohms on the 8 ohm tap (a damping factor of 0.16). The output of this amplifier will be GREATLY affected by the impedance of the speaker it is connected to. All of this is fine if you want your amplifier to act like a tone control over which you have no control except to change the loudspeaker!

As a slight diversion, note that for a given load impedance the 845 will have better damping than a 211 because of its lower plate impedance. The Ongaku uses a primary load impedance of 16K-20K! This yields good damping! The Cary 211 amp uses a 7.5K plate load (closer to the textbook load) and offers variable feedback, which is necessary to get a flat response into some speakers. Most PP amps do not use a high enough plate-plate impedance to achieve good damping without negative feedback.

Some amplifiers of old (Marantz 2, Altec 340, etc.) had variable damping. Essentially this allowed you to INCREASE the amp's output impedance to allow it to work well with certain speakers. The Heath Legato speaker provided a series resistor to be used with amps having a high damping factor (low output impedance). There are obviously subtleties which we can't go into here (like dynamic impedances).

I prefer the sound of a damping factor of about 4-10 which works well with the speakers I use (QUAD ESL, Altec A7, CLS, Acoustat, among others). This damping factor is easy to achieve with a single-ended triode output stage with zero feedback

Mike Somers
Chicago, IL

Gordon Rankin comments:

After several months of hindsight and further experimentation, I have a few corrections and changes to make to the Single 807 article in *SP* #2. The preparation of the article was a bit rushed in order to meet the publication deadline. [Hope the whip scars have finally healed - Ed.]

First, the amp sounds better with the filter consisting of R5 and C2 removed. This was discovered by the good folks at FI in NY. Also, as Mike Somers points out, my rushed calculations of output impedance were incorrect. I sent the amp off on an East Coast tour shortly after publication so I could not directly measure the output Z but I calculate a maximum Zout of 25.325 @ 10 KHz.

Right after SP #2 went to the printer, I realized that I had a blocking cap between my generator and the amp while doing frequency response measurements, causing a higher rolloff than the amp itself was providing. After re-testing, I found that the amp was actually only 3 dB down at 9 Hz. Yes, this amp had BASS. Not only did it measure good into a resistor but it was very tight, extended, and controlled — not "muddy" at all— driving a properly matched speaker.

The whole point of this exercise was to give this "neglected and rejected" topology a try. When I started out, I really didn't know what to expect. I was surprised at the good subjective results, as were others who have heard it. The most common reaction is "WOW, what bass!" followed by "I can't believe how good it sounds!" Sure, it won't beat my 845SE amp but it turned out to be a really cool piece. So all I can say, Mike, is try it you might be surprised too!

Mike Lefevre will be back next issue with another EXCITING installment of *The Core Issues* :

"POTTED TRANSFORMERS AND POTENT MYTHS"



W.A.F.

by Joyce

Have you noticed lately how this Wife Acceptance Factor thing, (a.k.a. Domestic Interference Factor), keeps on popping up everywhere? Just the other day, I came across "Toys for Boys?" by Barry Willis (*Stereophile*, January '93), another fascinating article written by a male on the perennial problem of women and audio.

What caught my attention this time was the author's solution to the dilemma: "Give women what they want: reliable, affordable, easy-to-use components *in a variety of colors* [original italics]." Oh boy, I thought, shaking my head, a whole article on what women really want in audio is color coordinated stereos (...when what we'd really like is husbands with taste).

I was skeptical. Honestly now, aren't silver and black and walnut brown stereos, that somehow still never manage to blend smoothly into the background, bad enough for you? I had sudden dreadful visions of fuschia tuners, puce speakers and amps of kelly green, all making their merry way into my home.

Then, as I continued reading, I saw the light. Colorized components are *just the beginning*. Hey, all you macho audio designers: take notice! Women, it says in the article, are "...not merely buying music. They're buying furniture and art. And if you want to place your product in their homes, that's what it must be: furniture *and* art."

I say this guy is right. Sisters, it's time to domesticate this audio animal, from those barbaric chassis and cabinets, down to the untidy, feral hardware inside. But why wait another few decades for the male-dominated industry to catch up? Let's bring our feminine talents to the task and start the Audio Revolution today!

Furniture *and* Art, Sisters! This shall be our battle cry!

In short, I've decided to become a professional audio designer. As I see it, when it comes to redoing your audio system, there's no need to limit your imagination to color; all kinds of patterns, shapes, textures and other decorative effects are possible. You'll see that to bring out the best in audio, all it takes is a little ingenuity and a woman's touch.

As Barry Willis put it in his article,

> "Whether our longing is for the good old days of 'family values' or the glory days of 'full employment' or the 'full, rich sound' of a Western Electric amplifier, we need to see such longing for what it is: a long look into a cloudy rearview mirror. Nearing the edge of the 21st century, we need a visionary approach to aesthetic, tactile, and application design. We need products which will carry us happily into the future, because that is where we are going."

Right on, Barry! Meet me at the vanguard, *and bring your wife!*

L'Audio Chez Moi: A Pictorial Gallery of Design

It's Beautiful...

Any piece of audio equipment, I've come to realize, can be transformed into an object of beauty. Among my favorite high fashion audio designs is the nostalgic "Horns 'n' Lace," a subtle fusion of form and function pictured below.





...it's Artistic...

Audio parts are ideal for craft making and other creative pursuits. For those of you still not fully convinced about the musicality of vacuum tubes, I can highly recommend the "Wind-Valve," a wonderful windchime ← *that's guaranteed to fill your home with beautiful sounds.*

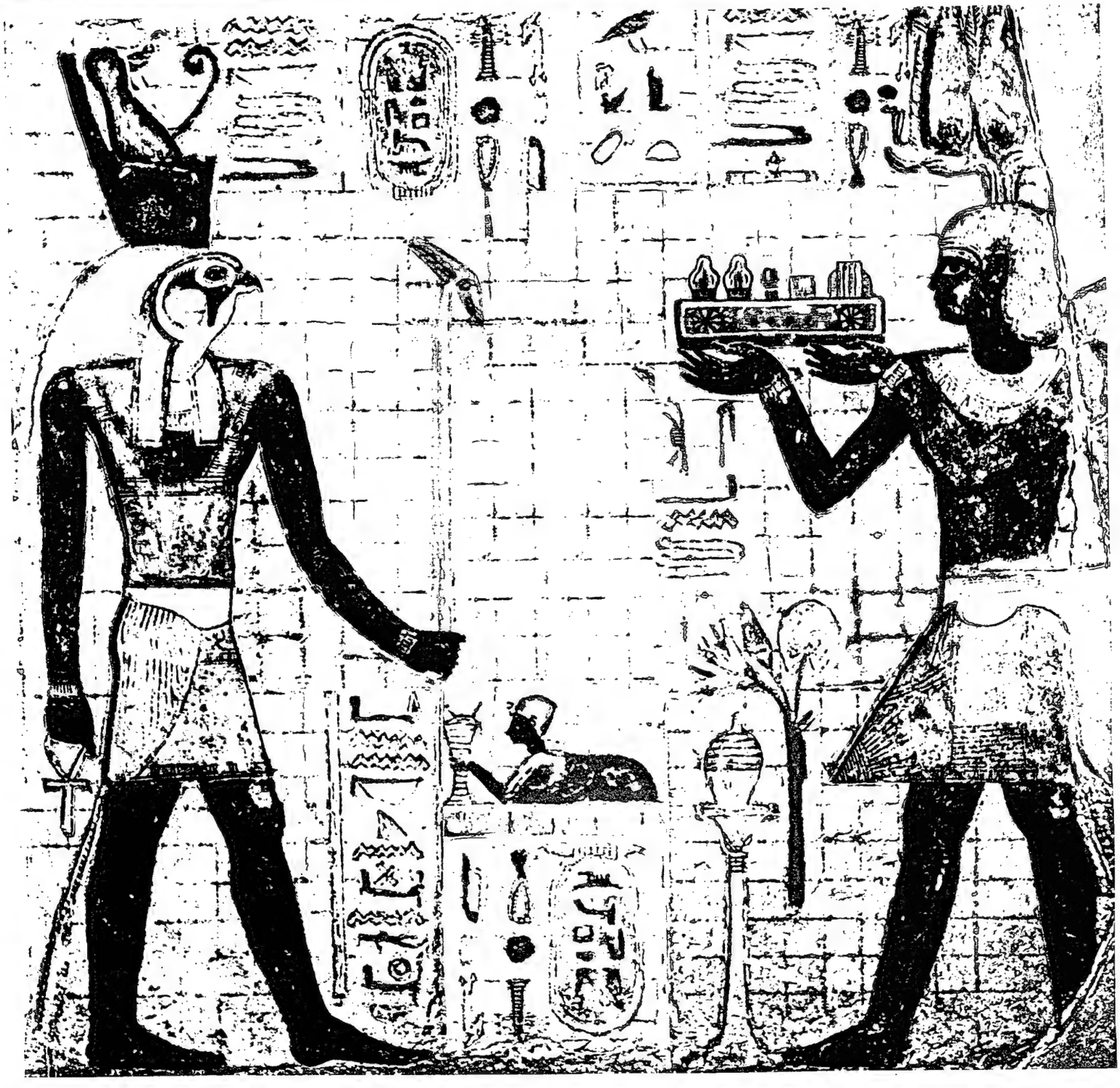


...and it's Useful, too!

Finally, I've also discovered that, aside from any musical merits, audio equipment can be put to many creative and practical domestic uses.

SOUND PRACTICES

A JOURNAL OF AUDIO TECHNOLOGY SUMMER 1993 FIVE DOLLARS



Old and New Technologies

Vol 1: #4

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. . . AND MUCH MORE !!!

Fellow Travellers

In an age when the upward march of progress is taken for granted in most fields, more and more audiophiles are embracing obsolescent vacuum tube technology. The advance guard even seems to be moving further and further back in time, reviving and reassessing circuits which first came to light in the 1920s!

The sonic rationale for keeping the filaments lit is certainly apparent to readers of this publication and discerning audiophiles in general. Although largely abandoned by the "serious" engineering community, vacuum tube technology refuses to die because users still consider it useful and appropriate.

For most enthusiasts of other obsolescent technologies, everyday functional utility is of secondary importance. Antique radio collectors treasure old radios precisely because such things are not being made or used anymore. Although some collectors do fire up their sets occasionally, simply having them and saving them for posterity is usually more important than using them. They are historians.

Indeed, many old broadcast radios are evocative and appealing works of period industrial art which engage both the eye and the mind. Even to the most crazed vintage audiomaniac, a shelf loaded with old EICO amplifiers simply doesn't have the visual impact of a display of art deco radio sets.

For the most part, the beauty of tube hi-fi gear (vintage *or* modern) remains hidden until it is turned on. There are some "collectors" out there, but tube audio, even vintage hi-fi, is primarily use-oriented rather than ornamental or historical. Vacuum tube audio is a living art.

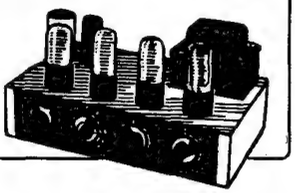
There is, however, another segment of the classic radio world that *uses* tube radios. A growing community of amateur radio operators (hams) is rediscovering the great communications radios of yore. They have character, they're easy to work on, and many are fine performers from a practical standpoint. Of course, most hams think the vacuum tube went out with men's hats — but there are quite a few around who really know how to have a good time with a technology that the mainstream gave up on decades ago.

There are contrary old timer hams out there who never did trust those darn silicon "three legged fuses". For some of these characters, the way to build a transmitter is to run a surplus metal 6L6 at 150 W dissipation inverted in a bucket of transformer oil so it won't melt down. If it worked well in 1953, it should still work in 1993. They've been around long enough to know that the laws of physics don't change that fast. But many of the "hollow state hams" are younger than the transistor. They see something in the glow of a tube that you can't buy at Radio Shack today.

They recognize the value in the idea of building your own gear and fixing it when it breaks. They are idealists, trying to capture the romance that radio once had, a quantity lost in today's world of LCD/LED lit microprocessor controlled "rice boxes". Compare a McIntosh MR-71 to a Panasonic tuner and you get the general idea. "Real radios glow in the dark," they say. They are right!

In this issue you will meet a few of these fellow travellers. You might also cross paths with these guys at swapfests or at the local surplus outlet. You want 2A3s for a single ended amp and they want 'em for the modulator deck of their WW II BC-610 transmitter. Hams are the *other* hollow state homebrewers, the other guys who read tube manuals in the bathtub, the other hobbyists keeping the orange glow burning. They are just like us — only the frequency range is different. We all recognize that real classics are always new.

New Products



SCOPE IT OUT

Perhaps the ultimate compliment on build quality is "Built like a Tektronix scope"— an accomplishment which very few products realize. *Oscilloscopes: Selecting and Restoring a Classic* provides over 370 pages of information on classic tube-era Tektronix instruments. Author Griffiths was a Tek service engineer for many years and his study displays a healthy respect for and intimate knowledge of these fine products. The book provides useful restoration hints, valuable advice for the flea market scavenger, and a useful glossary of 'scope terminology. An essential reference for the Tektronix fan. Available from the author for $19.95. ISBN: 0-9633071-5-0

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CHIMERA kyrie 211 AMPLIFIER

The *kyrie* is not your typical Wal-Mart single-ended 211 monoblock. One distinguishing factor is the attention lavished on the power supply. The voltage amplifier and the output stage are fed by shunt regulated supplies using an EL-34 and 211 respectively. Great pains were taken to ensure super low noise and low impedance power supplies are used for every tube's filament and plate supply — guess that explains why these babies are such a heavy load to tote.

Unweighted S/N ratio is over 100dBV below full output. Full power bandwidth is 11 Hz to 24 KHz with zero feedback. 100 pounds/15 Watts/$5500 per side. The sound is said to be summarized by its name, which means "Lord have mercy!"

Read all about this innovative design in this issue of *SP!*

CHIMERA LABORATORIES
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300B SINGLE-ENDED AMPLIFIERS

Eddy Electric announces a line of directly heated triode amplifiers designed by Herbert Reichert. Design goals are simple and elegant — uncompromised electrical and aesthetic realization and vivid musical reproduction.

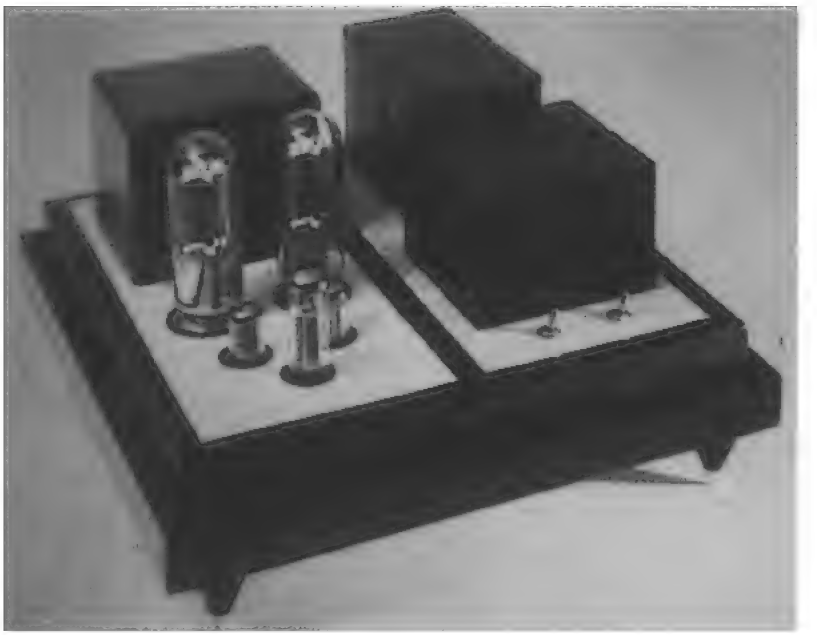
The REICHERT amplifiers are purist realizations of the legendary 300B SE topology. Eight years of experimentation and development preceded the final circuit and layout. A hand-wound custom transformer built to Eddy Electric specifications was commissioned from MagneQuest for this family of amplifiers. These amps deliver 7 watts of pure beauty into 4, 8, or 16 ohms.

This completely modern design is available in two versions. The COPPER version ($4700) uses a pure copper ground plane and an "all natural' selection of the highest quality parts including non-inductive wire wound resistors, paper-in-oil capacitors, and Kimber Varistrand wire. The SILVER version ($5900) has a pure silver ground plane, Kimber hyperpure silver wire, Teflon coupling capacitors, and Black Gate decoupling capacitors.

Both versions are hardwired and handcrafted to artisanal standards by Herbert Reichert. These amplifiers are pure Class A designs and employ no negative feedback. Handcrafting allows Eddy to offer a lifetime parts and labor warranty.

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DEVELOPMENT NOTES ON A SINGLE-ENDED 211 AMPLIFIER



Dennis Boyle
John Camille

Chimera Laboratories

Foreword *by Dennis Boyle*

In 1992, after over thirty years of building and modifying audio equipment, I decided to build a "test mule" single ended 211 amplifier to see what all the "fuss" was about. John Camille agreed to do some analysis and testing of the original prototype. At the time John was involved in preparing an article on a tube amplifier project and he had a very nice 8417 push-pull parallel triode amp put together. We listened to both amps in his system and the rest is history. After 40 years of push-pull audio, John was really "fired up" by the sound of a single triode. We decided to put our heads together and see where a dedicated single-ended design effort would take us.

After countless revisions and listening sessions, that "test mule" evolved into an amplifier that has converted a lot of "down home" fellow audiophiles. This collaboration blossomed into the founding of Chimera Laboratories and the commercial release of the *kyrie* 211 mono audio amplifier.

My background is in manufacturing operations and industrial design. I like things simple and I like equipment to look as good as it sounds. John has a broad and extensive technical background in military electronic, test and transmitting equipment and he is an ex-fighter pilot and "Top Gun" flight instructor. Where he comes from, sound design and reliability are key. His heroes are Tektronix, Hewlett-Packard, and Collins. For fun, he likes to design low-noise VHF/UHF receivers and do a little ham operation. Lately he spends a lot of time restoring and upgrading precision test equipment and adding audio test equipment to his RF test lab. He jokes that with just another $500K worth of test equipment he will be able to measure to the degree of precision claimed by many audio periodicals. He is precisely the kind of guy you want to have on the team if you're out to do some "serious" design.

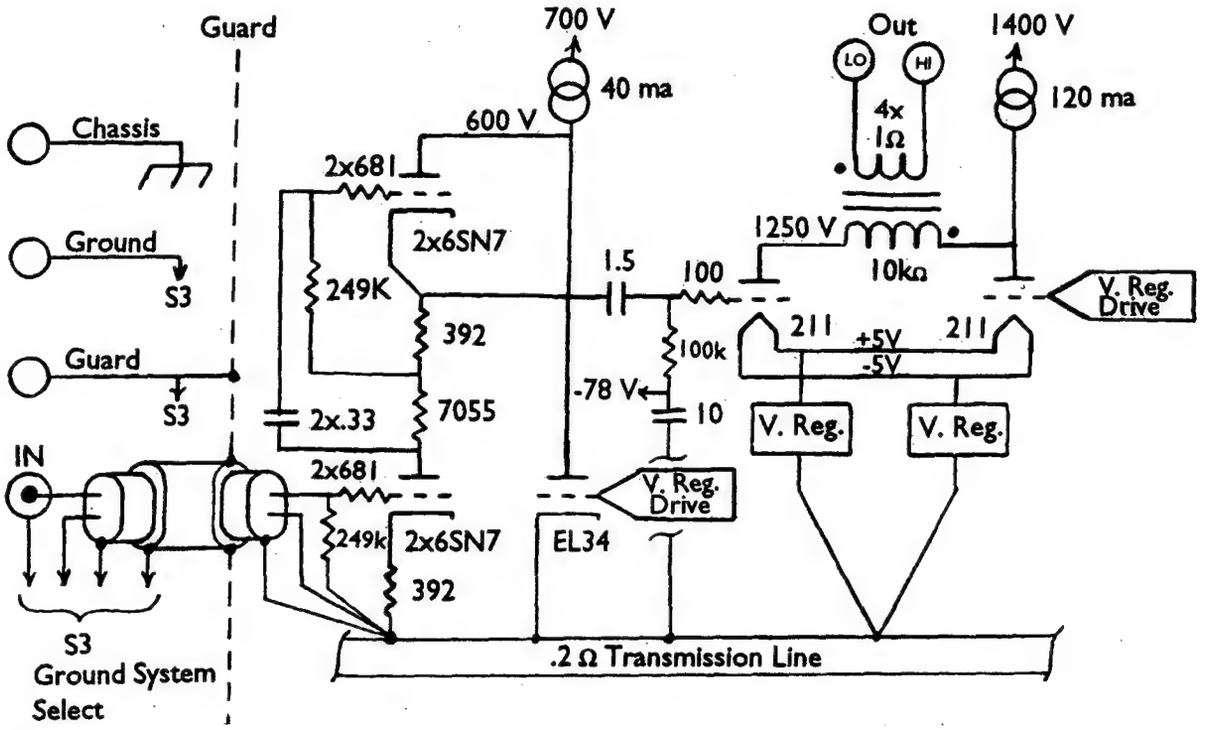
As it turned out, John's insights on layout and wiring, grasp of design principles from disciplines other than audio, and his meticulous attention to detail complemented my "plug it in and try it out" approach in the design of the 211 amplifier.

John and I feel that the circuits and concepts we finally ended up with should be made available to the audio community for evaluation and discussion. Audio design is a blend of science, component selection, execution, intuition and luck lubricated by lots of sweat. There is a tendency to use proven "classic" circuits and rely on component selection and execution to provide excellent sonic performance. That's the way the "old gray test mule" started out—simple design and good parts. As we progressed in the development program, we learned a lot that made significant improvements in sonic performance. We hope that this article will stimulate further experimentation and open some healthy discussions that will ultimately provide new paths to honor the music.

Design Notes *by John Camille*

Development of a single-ended 211 amplifier was started here at Chimera Laboratories early last year. The list of design goals included realism, resolution, repeatability and reliability. Our primary objective was to produce an amplifier that would fully exploit the excellent linearity of the 211 transmitting triode. We also wanted the amp to have excellent attack and very strong bottom end performance.

Sonic purity and reliability were to hold equal weight during the development process. When sonic challenges required an increase in circuit complexity, we maintained an appropriate level of derating of components in order to preserve overall reliability.



SIMPLIFIED SIGNAL CIRCUITRY

Early on, we adopted an aggressive Mean Time Between Failure (MTBF) goal of 10,000 hours of operation at an ambient temperature of 38°C (100°F). This reliability goal would include the tube complement as well as other relatively short-lived components, such as electrolytic capacitors. Inclusion of tube life in a reliability goal of this type is uncommon in this day and age of running tubes to the limits of their specifications. However, we believed that proper treatment of tube start-up, operating and shutdown parameters would provide an amplifier with a lifetime equivalent to the premier tubed test and transmitting equipment built in the 1950s and 1960s. Solid state devices are also operated at very conservative ratings with maximum junction or chip temperatures of 80°C to minimize bonding stress between a device's substrate and package during start-stop cycles.

Sonic strides were relatively large during the early stages as the more obvious problems were solved. As the design matured and we got smarter, changes became smaller and more systematic. End game changes were of the "snake oil" variety. Lately, we have been experimenting with component and wiring substitution.

I must admit, based on careful listening, that "theoretical nonsense" such as hookup wire construction can and often does have a real sonic impact. The difference between hyper-annealed copper and silver is audible even though the path length is measured in inches. The change is non measurable because it would be buried in the noise at levels 60 to 100 dBV below the noise floor. However this effect shouldn't be surprising when you consider that many "old time" radio-telegraph operators could pull signals out of the noise even better than the first phase-locked loop detectors which could lock onto a coherent signal buried 20 to 30 dB into the noise floor. The ear/brain interface is a wonderful thing and it is fun trying to fool it with our puny efforts.

Topology Overview

The signal amplification circuitry at this stage of development consists of a parallel pair of 6SN7s stacked in the so-called mu-follower configuration. The 6SN7 stack drives a single-ended 211 operating in Class A1. An EL-34 is used as a shunt regulator for the 6SN7 stack B+ of 600 VDC. An additional 211 is used as a shunt regulator for the 1250 VDC B+ supply for the 211 output tube. Thirteen other regulated DC supplies provide heater, filament, bias and other control voltages. Transmitting style control circuitry provides sequenced, soft-start turn-on and sequenced turn-off for the various supplies. In addition, various voltages and currents are monitored by an interlock circuit that will shut down the system during serious fault conditions.

The development of each of these circuits has a story that will be broad-brushed below. As in any blank sheet development project, the real story is not in the final result but in the hundreds of trials that were *un*successful. However, time and space do not allow coverage of each trial, test setup and results obtained. Suffice to say, we probably know many more methods that do not work than those that do.

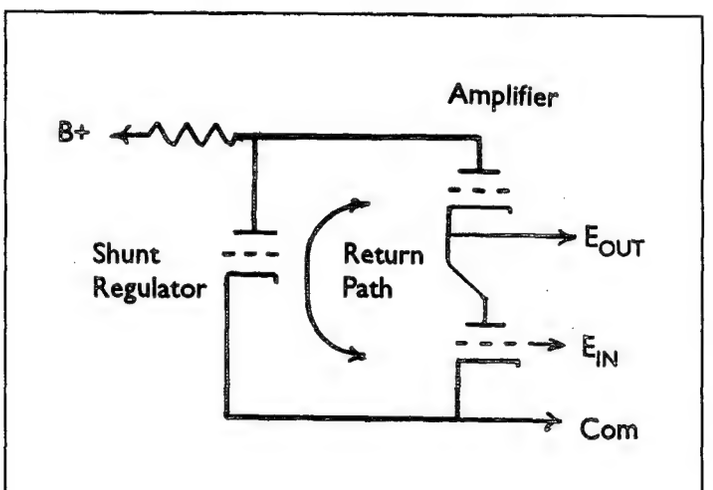
Voltage Amplifier or Driver Stage

The voltage amplifier (VA) stage must provide approximately 150 volts peak-to-peak drive to the 211 grid for full Class A1 input. This drive level, in itself, is not excessive until one considers the 211's grid-to-plate capacitance and the Miller Effect multiplier.[1]

This grid/plate reactance, in parallel with the various real and dynamic resistances found in the 211 grid circuit, result in the need for approximately 0.5 W of peak drive power in order to achieve a reasonable bandwidth. The typical "cookbook" VA stage cannot provide this power with any degree of accuracy resulting in poor dynamics and sonically detrimental distortion effects.

Trial and Error

We conducted empirical trials of dozens of low output impedance tube/topology combinations based on various octal triodes, including a number of cascode or stacked variations plus cathode follower configurations. Initially, we had high hopes for high transconductance triodes but listening results were typically poor—even though the "specs" looked very good. Along the way, we made a number of critical discoveries about the sonic effects of the power supply. Essentially, the VA must be decoupled or isolated from the power supply to a *much* greater extent than we ever anticipated. Also we determined that the upper plate in a cascode stack or the plate of a cathode follower must be returned to ground through a very small AC impedance in order to truly make it "sing." The conventional use of bypass capacitance produced a muffled signature. This finding led to another development effort we will cover in more detail later, the shunt regulator.



SHUNT REGULATOR CONCEPT

The shunt regulator provides a short, direct signal path to ground, and with proper implementation, a low AC impedance. This unconventional approach is rarely seen in tube equipment because it is inherently very innefficient—the regulator consumes as much power as the regulated circuit, *more* in our implementation.

Another discovery made during experimentation with stacked voltage amplifiers was that a significant amount of "trash" was being coupled from the upper tube's filament to the cathode sleeve and thereby into the signal path. The cure was to provide a highly decoupled floating DC supply for the filament. Again, this problem will be discussed in more detail later.

Through continual experimentation and listening tests of low impedance drive stages, we eventually settled on the mu-follower configuration. We felt that the mu-follower offered the best level of sonic performance compared with other stacked configurations, all of which bettered the cathode follower to our ears.

During the above sonic trials, after blowing the dust off of a lot of tubes we ultimately came full circle to the "tried-and-true" 6SL7/5691 and 6SN7/5692. We initially selected the 5691 for optimization in the mu-follower configuration. Two of these tubes, with both tube sections tied in parallel, would swing just enough current to drive the theoretical 211 grid load to somewhere around 50 kHz. The 5691 combination was, indeed, able to drive the 211 grid to 35 kHz in the "brass-board" and eventually to 46 kHz in the prototype. The prototype had a slightly better component layout plus an in-house design, low capacitance 211 tube socket. In order to achieve the required drive levels, it was necessary to bias the 5691s to the maximum permissible plate dissipation.[2]

During later listening tests of the first "real" prototype, the inevitable tube "switcherama" began. Eventually, we plugged in a pair of 5692s and everything seemed to fall into place. Even though the 5692s were biased well down into their nonlinear region with the existing 5691 biasing, they sounded as smooth as the 5691s and had much greater attack on the low end. Triangles and bells now really sparkled on the high end and "rim shot" detail was greatly improved.

The second prototype was set up with proper biasing for the 5692 combination. Each tube in the stack was operated at a quiescent plate potential of 227 volts and a combined plate current of 18 mA. Plate dissipation under these conditions is slightly below the recommended operating point and well below the operating maximum (4W versus 7.5W). This operating point is centered in a sizable area of operating conditions that exhibit the same distortion level, thus minimizing aging effects.

Full power bandwidth of this stage was now 250 kHz and the sonics were well into "goose bump" territory. Inexplicably, a later change to a garden variety 6SN7WGTA rewarded us with greater apparent speed and much better apparent dynamic range, even though the measured performance did not change. We still haven't uncovered the reasons why the highly touted 5692 sounds very slightly lacking in inner detail when compared to the 6SN7. [This was a great disappointment for me. I had been hoarding Red tubes for years, even kept a few on my night stand—Dennis]

---

[1] The grid-to-plate capacitance of a common cathode amplifier is increased significantly by a phenomenon called "Miller Effect." Very roughly, the static Cg-p is multiplied by the AC gain of the stage. For the 211, the Cg-p (14.5 pF) is multiplied by the amplification factor (12) to about 170pF. Consult texts for a proper understanding. This effect also explains why simple pentode to triode conversions rarely work well because of the greatly increased load capacitance.

[2] The 5691 is rated for 10000 hour service at a recommended design center that occurs around *one-half* the maximum dissipation.

VA Characteristics

Measured output impedance of the VA stage is less than 600 ohms (430 ohms) and full power distortion (approximately 150 Vpp) was 0.4% (-48 dbV) throughout the 20 Hz to 20 KHz range. Distortion numbers at 1 W equivalent output are approximately twice as good (0.2%/-53 dbV). These distortion numbers are comparable to many systems using feedback. Out-of-band distortion (20 kHz to 100 kHz) rises gently to 0.3% at 100 kHz. A 0.3% bump in distortion also occurs at the 70 kHz self-resonant frequency of the output transformer where the worst case load exists. The VA stage has over 6 dBV of headroom in that it will drive a pseudo-grid (non-clipping) dummy load to 350 Vpp. Clipping is nicely rounded when a real world 211 grid is driven into the positive region and the amplifier sounds perfectly acceptable when driven to the 30 W level—well into Class A2 operation.

The VA stage and its voltage regulator are unconditionally stable at all plate voltages between 0 VDC and 700 VDC. Inductive and capacitive speaker loads reflected back through the 211 output stage cause minimum change in VA wave form. Also, parasitic oscillations could not be induced under any operating conditions up to an input overdrive of 60 Vpp of sine, pulse or triangle waveforms! Swept input waveforms between 0.003 Hz and 1 MHz produce no spurious products, an attribute of no global feedback.

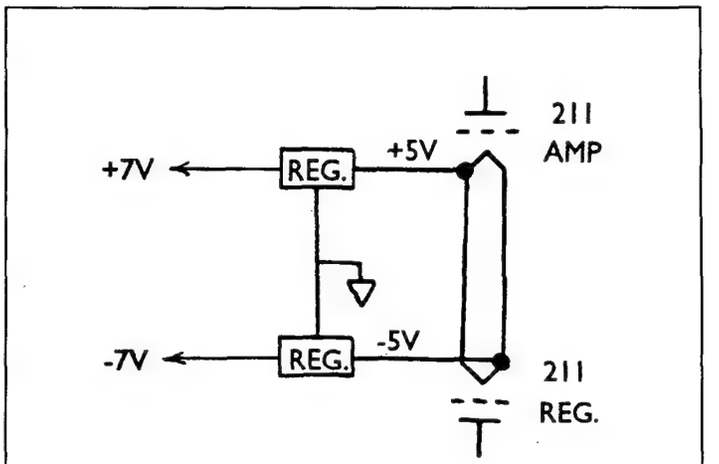
211 Power Amplifier Stage

We originally thought that the 211 power amplifier (PA) stage would be a "piece of cake" since all one had to do was "light the fire" and add B+. We assumed that a stage operating at the planned power level would be immune to the normal problems associated with low-level stages. However, this was *not* the case.

We discovered that numerous artifacts from existing "cookbook" power supply topologies would show up in the output signal. Thus, the story of PA stage development is primarily one of power supply refinement. Simply put, we determined that the 211 output stage must be supplied with highly regulated and very clean power for the best sonics and to provide a good signal-to-noise ratio (SNR). Otherwise, the PA stage seemed to process "garbage" as well as it processed the desired signal. In more polite terms, the 211 SE stage had a poor power supply rejection ratio (PSRR).

We also learned that the 211 does not really "come alive" until the B+ is raised above 1200 VDC and the "after-burners" kick in around 1250 VDC. This presented an interesting engineering challenge in building a low-noise HV supply. Being of single-ended design, the amplifier has none of the noise canceling effects of push-pull designs. B+ and bias supplies must be filtered and isolated to the same extent as the low-level stage supplies.

We encountered another set of surprises in working with the 211 filament circuit and here we feel that we made a very significant degree of sonic progress. Conventional AC and DC filament supplies force the entire audio signal return path through the filament winding and other power supply components to ground. In addition, it was virtually impossible to bring both ends of the filament to the same AC impedance (to ground) over the amplifier's bandpass when using conventional approaches. This factor led to a symmetrical design using two regulated 5 VDC power supplies operated in a center-tapped series arrangement providing +/-5 VDC at the filament terminals.



FILAMENT SUPPLY CONCEPT

The much lower AC impedance of the regulators shunt a majority of the signal current to ground, thus bypassing the majority of power supply "nasties." This filament supply topology produced one of the most significant sonic improvements during the amplifier's development. Additionally, each improvement in regulator speed and in lowered dynamic impedance brought forth better sonics. The prototypes presently operate with LT1083-5 chips as the regulator element. This device has both a very low output impedance and an extremely low noise figure that measures several times better than other regulators.

We suspect that there is room for further sonic improvement in the 211 filament supply area. We are presently working on a dual shunt regulator using MOSFETs driven by video amplifiers. An order of magnitude improvement in dynamic impedance with an additional 6 to 10 dbV decrease in filament noise current appears possible.

211 Power Amplifier Stage Topology

The 211 PA stage development was, as mentioned earlier, a power supply problem. Otherwise, the topology was relatively simple. A grid bias of -75 to -80 VDC was delivered to the grid through a 100 K resistance. Bias is adjustable to set the plate current within a 50 to 60 mA range. Listening tests have shown that there is no advantage in increasing plate current over the prescribed 60 mA. No detriment in sonics is detectable as the plate current is reduced to 20 mA. However, such a large reduction in plate current would reduce the maximum power output capability and dynamic range would suffer on speaker systems with sensitivities of less than 100 dB SPL. Since 211 emitter life is more a function of plate voltage (ion bombardment) than reasonable plate currents, plate current is set at the specified 60 mA for maximum Class A1 dynamic range.

The heart of the 211 PA stage is of course the output transformer. The core and winding are about the same size and weight as a typical 500 W push-pull output transformer or a 1 KVA isolation transformer. The multiple interleaved primary has an impedance centered around 10K ohms at 20 Hz. Primary inductance is over 100 H at a current of 60 mA. Saturation effects are not visible on the full power output waveform above 20 Hz. 3 dBV bandwidth is 11 Hz to 24 kHz at full output. At normal listening levels, core saturation effects are not visible down to 5 Hz.

Secondaries are brought out of the winding stack with individual leads that tie-off to an array of insulated terminal posts. This arrangement allows strapping for output impedances between 0.5 ohm and 16 ohms. Strapping of these windings is done by soldering suitable busses across the appropriate terminal posts. Screw-type, quick-connect strapping schemes were discarded because of possible sonic degradation with age in high humidity locations due to galvanic action. This decision was also in keeping with an overall design philosophy precluding mechanical connections within the amplifier.

Conclusion

To some, the whole concept of building a 100 lb. monoblock in order to experience 15 Watts of single-ended sound might seem a bit "obsessive"— however, listening to it can ruin your happy life with push-pull tube amps or transistor amplifiers.

We are nearing completion of the development program on these amplifiers. All the midnight hours, the thrill of discovery, the adrenaline rush to complete something for testing, have been replaced by a deep sense of satisfaction every time we light the fires to listen.

The prototypes have been running for over 6 months in their current configuration. During that time they have not required any adjustment or tinkering of any kind and they simply ignore any planned or accidental destruction testing. There has been a steady stream of "audio fanatics" knocking on the door of the converted movie theater that houses Chimera Labs. Many carry in amplifiers and other gear for evaluation. We even hosted a few visitors who flew in from Europe and the Far East. It usually takes only a few minutes to compare amplifiers. The *kyrie* prototypes just don't seem to have any sonic signature. They don't color or erase the music at all. One "golden ear" found that they were too accurate—his "holy grail" is a system that would make all recordings sound *good.* The *kyrie* tells it like it is.

Chimera Labs is only a few minutes from the Dallas-Ft.Worth Airport, so on your next layover c'mon over for some fine Texas chili and some mighty good listening—don't forget to bring your favorite "system killer" record or disc.



John (foreground) and Dennis testing custom X-over for a theater-style horn system using a modified RCA PL-304 bass horn with Altec 802 driver on a well damped 329A horn.

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A no-nonsense line conditioner

by Mike Vans Evers

WARNING: This project, like many others, involves working with voltages and currents that can kill you or burn down your house with you in it. So please, please don't attempt it on you own if you aren't well beyond the beginner stage.

I hope that it comes as no great surprise that line filters will improve the sound of your audio system. I'm not going to try to prove it to the skeptics. I'll just nod in agreement and congratulate them when they DO discover the benefits of less noise filling up the blank spaces in their music. Line filters have been around in commercial use for several decades, primarily for keeping RFI/EMI out of computers and other digital equipment. Tice, API, and others have made versions that are application specific for audio that, according to many thousands of users, do a good job.

I have been making line filters for several years. Until May of this year, they were just another "something else" that I researched and then built. They were used in recording and playback systems for pro audiophile recordings. Other people had heard improvements, but I hadn't taken the time to do a serious 'before and after' listening test. When I did, I can tell you that it was a big eye opener! To make a long story short, line conditioners and power cords are what I "do" now.

This isn't the high-class design that I'm presently marketing, but it is a DIY design that is effective and fairly easy to build. It will help clean up some of the noise that the power line is "powerless" to prevent from grunging up your sound. I measured attenuation at 1 MHz of 50 dB for the first section, 70 dB for the second, and over 80 dB at the digital outlet.

I tested the frequency response of one of the power transformers that I used as a choke in this project. It was flat from 20Hz to 2MHz; then its response tilted UP and it peaked at 5MHz! Scary, yes? Electronics, both passive and active, are full of self-resonant passive components. *All passive components, especially transformers and capacitors, resonate.* Unwanted RF noise *can* play havoc with your electronics.

The filter elements that I've selected are easy to find used or surplus. If you can't find a local source try Fair Radio Sales in Lima, OH. They should have something that will work, and for a great price. Corcom-type filters can be had from most surplus outlets, including Hosfelt Electronics at 1-800-524-6464.

A high-end audio magazine recently published an article focusing on a line filter that used a choke as its only element. Yes, this approach will work, but there is a price to pay. A mention was made about loss of dynamics and this is the direct result of the AC and DC resistance of the choke. To keep from repeating this mistake, my DIY line filter uses multiple stages and doesn't use series elements that can adversely affect the 60 Hz impedance of the line in the mains supply to the power amplifiers.

The line filter's duplex outlets are mounted to 4" X 4" metal covers that mount to 4" X 4" extension-type bottomless metal electrical boxes. These boxes are then mounted to a wooden box that contains the main filter elements. Use a piece of copper wire to daisy-chain the green screws together. The metal electrical box parts are available from many sources. The line cord's line, neutral, and ground wires are connected directly to the outlet that your power amp will use, thus minimizing the AC/DC resistance. The white-jacketed wire is "neutral" and connects to the silver-colored screw terminal. The black-jacketed wire is "line" and connects to the brass-colored screw terminal.

The first filter element is 2-4 uFs worth of 2000V oil capacitors. This is wired from line to neutral across the first outlet. Underwriter's Laboratories says DC rated capacitors for across-the-line use should be rated at least 1500 VDC. I like to exceed UL ratings, hence my selection of 2kV caps. A 25 amp-125 VAC fuse is wired in series with the capacitor. The fuse will blow if lightning causes the filter/surge protection elements to short. The high value is necessary because derating is necessary when dealing with the micro-second, high-amperage current pulses associated with lightning induced surges. The MOVs are protection against surges and should be wired through fuses because the failure mode for MOVs is to short-circuit.

The next element is the high amperage, dual secondary transformer. This gets wired as a common-mode choke with one secondary winding in series with the line, and the other secondary in series with the neutral. Both secondaries have to be wired in-phase (see "how to" diagram on pg. 9). The primary will not be used and should be well insulated with electrical tape to prevent accidents. There will be some leakage between the secondaries and the case of the transformer, so ground the case.

The third element is 2-4 µFs of 1500-2000V oil capacitors. This voltage rating can be slightly lower than in the first stage because transient spikes will be reduced first by the MOV across the first filter element and second by the choke. Two or more duplex outlets across this filter will provide power for preamps, tuners, analog tape decks, etc.

An optional fourth filter element will further clean up and isolate "things". A surplus Corcom-type filter can be wired to the third filter element or, if you already have one, a Tripplite can be plugged into one of the outlets across the third filter element. Surplus filters come in many shapes, sizes, and amperage ratings. If you are not ignoring the convenience of digital and have a CD player, then almost any Corcom-type filter will work. If you have an extensive video set-up, then use a 3-6 amp filter, or use a Tripplite plugged into one of the outlets wired across the third element. Mount the surplus Corcom-type filter to the wooden box. Use two filters if you have both digital and video. This keeps the one from interfering with the other, and both of them from interfering with your analog.

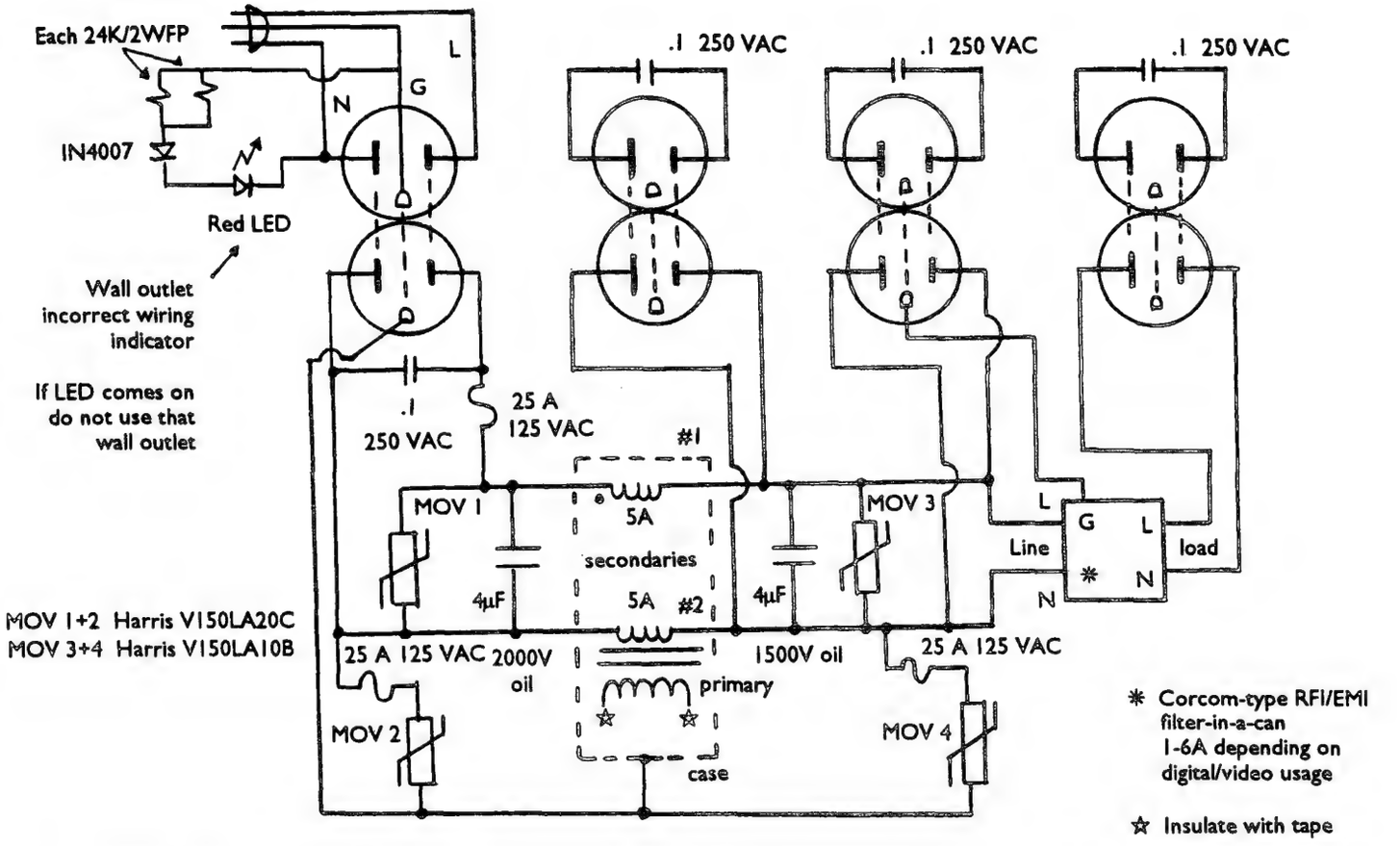
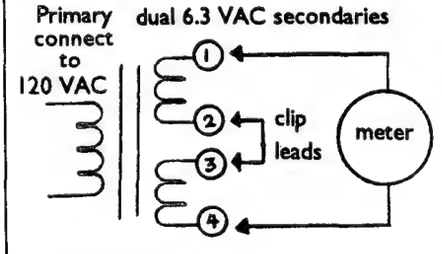


Fig. 1— SCHEMATIC OF LINE CONDITIONER

That completes the description of the placement of the major filter elements. A 0.1 μF 250VAC UL approved capacitor should be wired directly across each outlet. Wrap the leads CCW around the screw terminals. Tightening the screws will then tend to loosen the tension on the capacitor leads, rather than pulling the leads off the capacitor.

Procedure for finding the in-phase ends of the filament transformer secondary



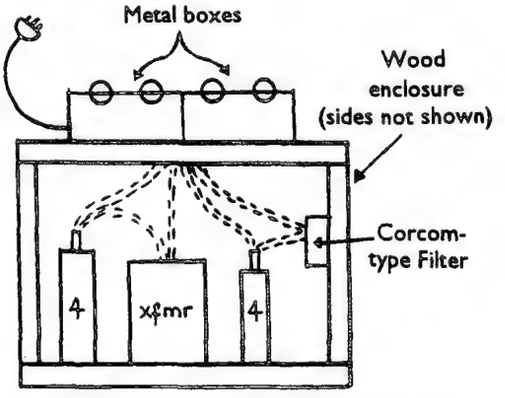
If meter reads approx. 12.6 V, use 1 & 3 as input

If meter reads approx. 0 V, use 1 & 4 as input

A voltmeter test should now be carried out. A low-Ohms or "continuity" setting should be selected. Use the probes to try all combinations of an outlet: line to neutral, line to ground, and neutral to ground. There should be no continuous low-impedance reading or continuous "bee-eep". If there is, start at the last outlet and disconnect its wires and retest. Do this until you find and correct the problem. A momentary low-impedance reading or short "beep" may be noticed when checking the line and neutral. The key word is "momentary." As the 4 μF cap charges up, the beep or the low-impedance reading will go away. This is normal and is to be expected. It's also a good way to tell if you remembered to put in a fuse.

Next, check for continuity between all the tall slots (neutral) of all the outlets. Do the same for "line" and ground.

Install and enjoy.



Fasten caps & xfmr to case with silicon glue

Fig. 2 — SUGGESTED LAYOUT

Parts Sources:

Fair Radio Sales
PO Box 1105
Lima, OH 45802
419-223-2196



The Classic Williamson 1993 style

by Bill Kleronomos KDØHG

A hollow state traditionalist says "Up Your Ongaku" to all you puny single ended triode freaks

By way of introduction, I'll say I've been a ham for almost 30 years now, and the world I come from is one not too unfamiliar to most readers of this rag. Having rejected the premise that operating modern soulless, bell and whistle festooned imported ricebox radio appliances has nothing to do with what real ham radio is about, my shack contains nothing but the radio world's equivalent of your classic audio gear of the 30s, 40s and 50s.

Those of you impressed by death dealing instruments of destruction would be awfully impressed with the 450 pound, 7 foot high rack mounted plate modulated kilowatt transmitter I completed several years ago. There's nothing quite like the ceramic, silver and steel hardware required to generate vast amounts of RF energy, and there's nothing like sitting back in an easy chair, squeezing a microphone's switch, and watching a pair of tantalum anode glass tubes with three kilovolts coursing through them lighting up with a white heat reminiscent of Flash Gordon's atomic furnace.

But I digress. Some time back I became obsessed with the idea of constructing a stereo amp for use in the family living quarters as a consequence of upgrading my preamp and CD player. Having only recently discovered the parallel world in the other dimension of hollow state audio in the last two years (via *Glass Audio* and *SP*), my level of sophistication is perhaps not as refined as those of you who live, breathe, and eat single ended audio and perhaps also despise the concept of inverse feedback.

So let me put it another way: the amplifier I'm presenting in this article is nothing more than two single ended amps, connected in a manner that allows only one amp to work at any given instant. It is not really "push-pull"! If you hate inverse feedback, that's OK. You only need to omit one component to dramatically increase distortion products, noise, and reduce the damping factor, gain flatness and bandwidth.

I had no desire to reinvent the wheel during my quest for a high performance amp design, and I don't have the luxury of enough spare time to spend months or years tweaking a circuit in search of perfection. I wanted a darn good, solid, reliable unit that used no exotic or expensive tubes that we could just sit down and listen to some good tunes on. One circuit that kept popping up during my research of good old designs was the one by D.T.N. (Theo) Williamson.



Bill and his mighty homebrew 1 KW plate modulated AM ham radio transmitter—304TL triode modulated by push-pull 810s. The modulator deck is good for 700W of audio at 5% THD!

The Williamson amp might very well have been built by more home constructors than any other over the years, and nowhere in the literature did I ever find any suggestion that it sounded "bad" or had any outstanding sonic deficiencies. If thousands were indeed built or purchased by people of all levels of sophistication, acoustic taste and with the use of innumerable types of preamps and speakers with few complaints, who can argue with success? I challenge any of you engineering geniuses out there to design a product that thousands will praise and few will pan over a forty year period. By any measure, doing so would be considered a success in design. So it is with the Williamson.

Let's take a few minutes to look at the history of this classic amplifier design. Theo Williamson was a young man in his 20s who worked as a tube development engineer in the English laboratories of the Marconi-Osram (M-O) valve company. Sometime during the mid-1940s he became intrigued with the idea of developing an essentially distortionless amplifier and spent many hours of his own time in pursuit of this goal.

At that point in history, the best amplifier designs used a push-pull pair of triodes or pentodes with an inverse feedback loop that ran from a plate of one output tube back to the input stage. It was recognized at the time that factors such as imperfect coupling and imbalances between the halves of the transformer primary and core generated distortion were significant contributors to distortion and lack of gain flatness in an amplifier's design, but attempts to control these problems by including the output transformer within the feedback loop caused nothing but trouble when a large amount of feedback was used. The reason for this is that at the extremes of the audio range phase shift occurs in both the output transformer and in a conventional amplifier's circuitry; at some point the phase shift becomes significant enough that the amplifier will become unstable or oscillate. Williamson was perhaps one of the first to realize that a good amplifier needs to be designed on a holistic basis with the output transformer considered as part of the design, not as something hung onto the back end of an otherwise sound product.

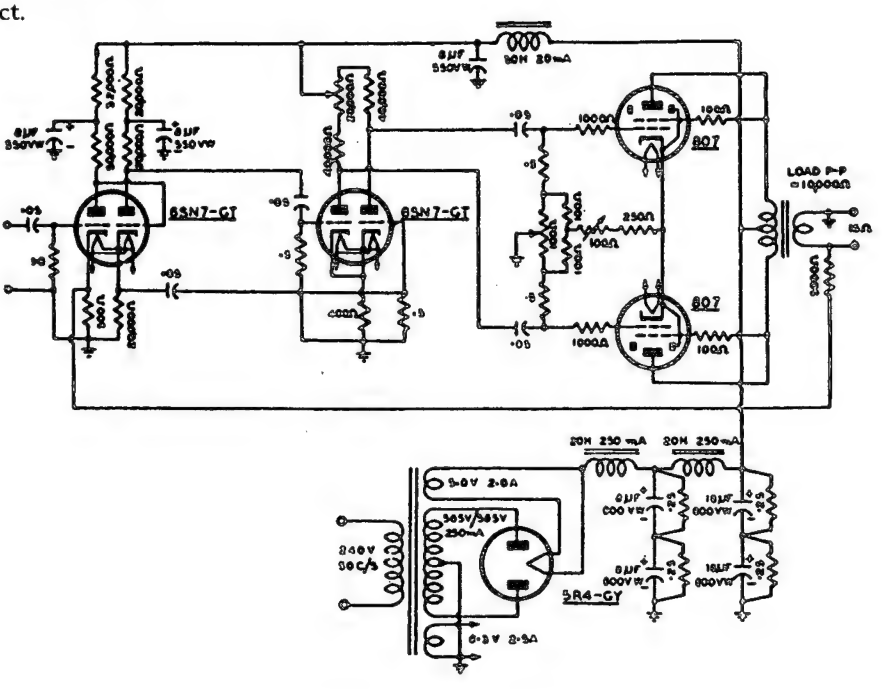
Williamson's answer was to design an output transformer of exceedingly high specifications and quality and to minimize or eliminate the use of bypass and coupling capacitors in his amplifier's circuitry to minimize phase shift. The basic structure of his amplifier is well known: four all-triode stages consisting of DC coupled voltage amp and phase splitter, and push-pull driver and output stages. Williamson was able to minimize phase shift over many octaves with his simple design and so it was possible to incorporate a degree of overall feedback sufficient to reduce distortion to far below audible levels in the tents of a percent range. The 22 year old Williamson had succeeded in designing an amplifier that had measurable performance far better than anything else available in the mid-40s.

I wondered just how good the basic Williamson design could be if one used more modern and better performing tubes and components than were available in his day. The main drawback of the Williamson design for my application was its power rating of around 20 watts when using a pair of 2A3s or triode connected 807s. I have to share my living quarters with two energetic preschoolers, a wife and all the accessories that are attached to same, and I don't occupy an 8,000 square foot chalet at the foot of Aspen Mountain. So, for reasons of size, I gave up my homemade bass reflex/horn enclosures years ago in favor of a pair of large Advents, which still ain't bad on-axis speakers but need more watts than your typical surplus high school gym speaker and P.A. horn robbed from a police car hermaphrodite system used by many with their puny overpriced SE amps.

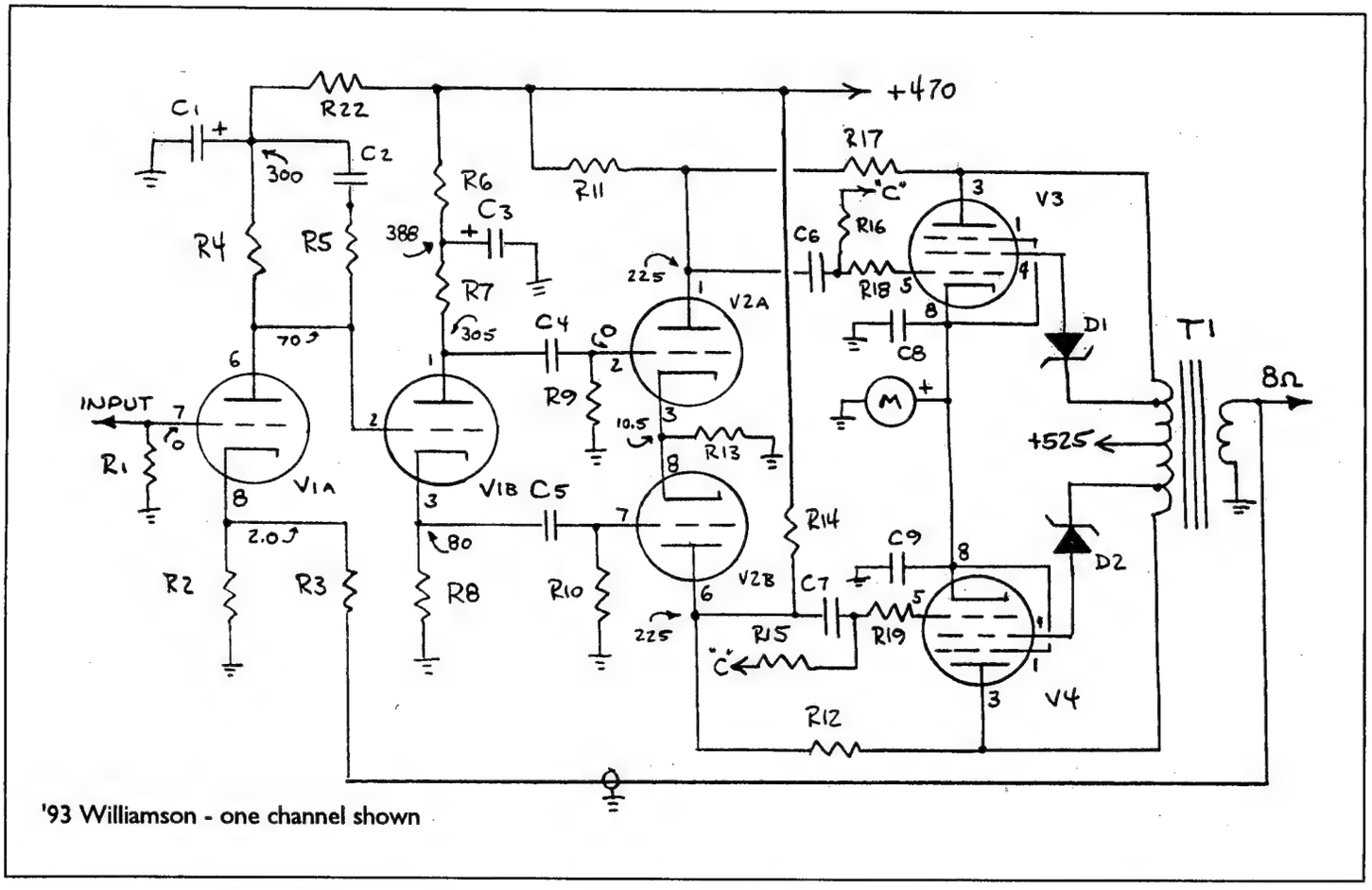
Somehow when I think of your typical SE amplifier, I'm reminded of a Yuppie-French-Whole Earth restaurant in Boulder I ate at once when my $19.95 plate arrived with more white than food visible and my wife telling me how wonderful my "delicate portion" was in presentation. For me, single ended = All-American 5 tube table radio; a mental block I suppose, and all I'll say on the subject. Just so you know where I stand — now gimme that chicken fried steak, *garçon*.

The answer to my power requirements was the well known ultra linear output stage a la Dynaco. I certainly wasn't the first to utilize a Williamson/Hafler hybrid as I'm aware of at least one published design from the mid-50s, and it looked like a good deal.

One area of improvement I wanted to pursue during my bench test phase of the project was the replacement of the originally specified 6SN7 amplifier stages. One interesting article I found was one published in Audio Engineering of August 1952. The author of the article suggested the replacement of the 6SN7s with a 12AY7 preamp phase splitter followed by a 5687 driver stage. I didn't care much for the idea of using the fairly hi-mu 12AY7 and I really didn't like the 5687 for being an industrial tube. "*What?*," you say.



Original 1947 Williamson



'93 Williamson - one channel shown

Some time back *Electric Radio* magazine (for vintage radio enthusiasts) published an interview with the designer of the Collins KWM-2 HF transceiver. This radio, for the uninitiated, was designed to be a no-compromise military and top of the line radio for embassy, government and amateur use in the late 1950s. The article went on to say that the Collins engineering team called in representatives of the American tube manufacturing companies, told them about the project and their tube needs, and asked them to suggest the absolute most reliable tube types for the application. What special developmental military types could they use?

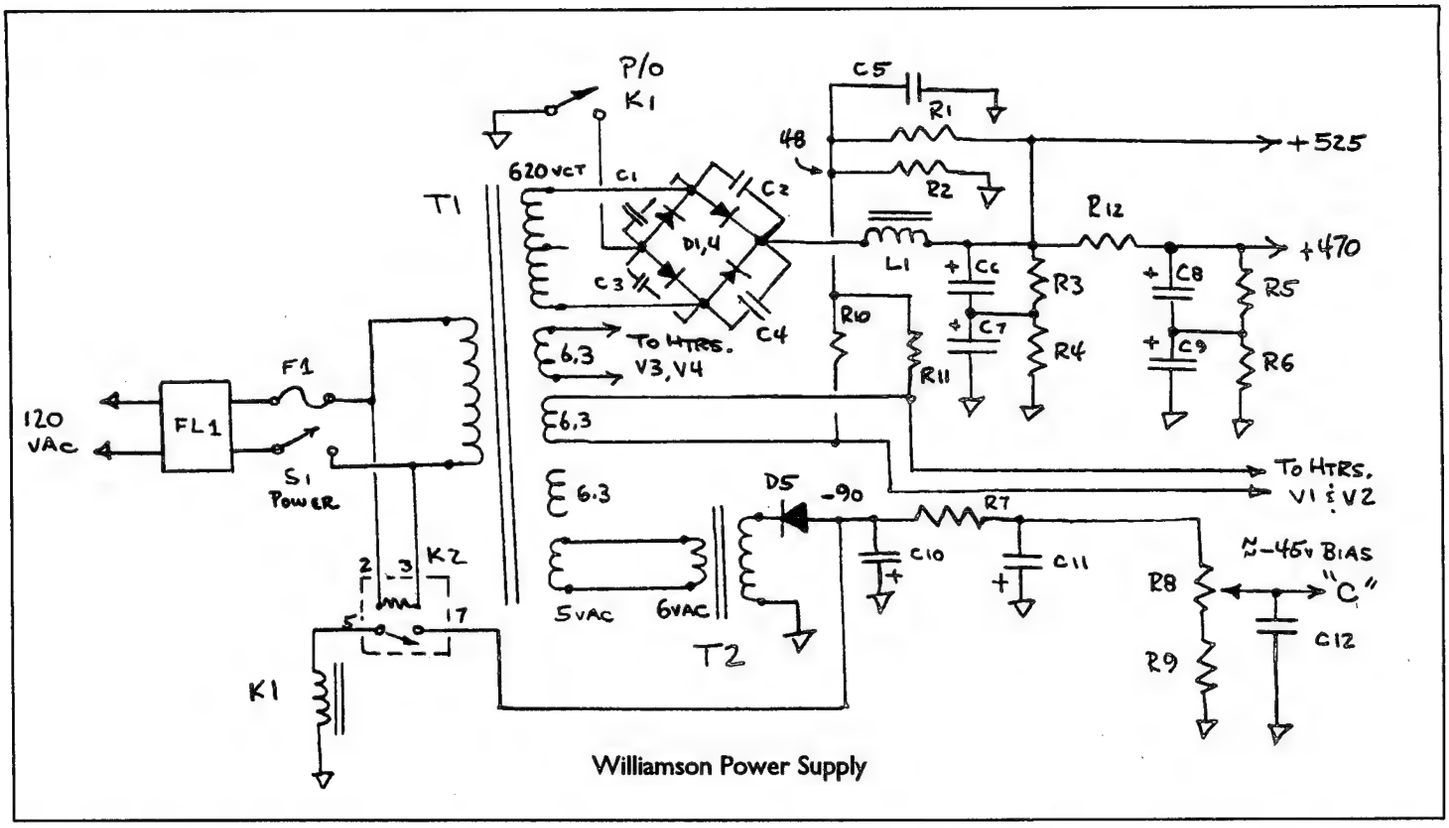
The answer they got from the tube engineers might surprise you. The Collins staff was told that the most reliable tubes made were the one made in the largest quantities — your standard TV and radio tubes. RCA, GE, and Sylvania had garnered so much experience and feedback in making these types of tubes and were so far up the learning curve that durability and reliability on a percentage basis were excellent. Yes, some military numbered equivalents of civilian tubes received extra tests on a sample basis, but were the same tubes sold at your corner TV store, and by and large those special industrial types made in relatively small quantities had no more longevity than your standard types.

Is a 5692 truly a better, longer lasting, more reliable tube than a 6SN7GTB, or does all the extra internal mica and hardware assembled by more inexperienced production lines create more potential points of failure? Do the tubes in preamps really need the extra internal bracing to withstand a 500g shock? Are a lot of industrial tubes being used for pragmatic reasons, or just snob appeal?

In any event, there's nothing wrong with using the originally specified 6SN7s, but I did want to refine the circuit in my own individual way. After several evenings studying my RCA HB-3 tube manuals and laying out some loadlines I decided to use the 6DJ8 for the amp/phase splitter and a 12BH7 as the push-pull driver stage. My logic behind selection of the 6DJ8 was that its a low noise tube, originally designed for use in cascode VHF amplifiers. Other advantages are that it uses a rigid frame grid, which would theoretically tend to minimize microphonics, and the amplification factor at 33 was lower than that of the 12AY7, allowing more signal level headroom at the input.

The 12BH7 was chosen for its low plate resistance, high plate voltage rating, and once again, low amplification factor and subsequent ability to handle large signal voltages. In class A amplifiers the total harmonic distortion is almost directly proportional to the output voltage being delivered as a percentage of maximum output capability. In other words, big output voltage capability = lower distortion.

On my bench, the Williamson dual 6SN7 combination was able to produce a maximum peak to peak output voltage swing of about 110 volts at about 5% THD. The 6DJ8-12BH7 lineup was able to put out in excess of 250 volts P-P before clipping at a measured THD of 2.9%. At the 40 volt P-P level, the approximate operating level in the complete amplifier, I measured a THD near .35%. The revised tube lineup was significantly better in all respects and I decided to go with it.



Williamson Power Supply

A note on tweaking the above described stages. I plotted a dynamic characteristics curve for the 12BH7 and selected a nominal value of 950 ohms for the common cathode resistor. It is possible to achieve somewhat lower values of THD in the completed amplifier by reducing the value of this resistor to around 750 ohms. The downside to doing this is that I observed a small ringing type of oscillation on a portion of low frequency (about 20 hz) waveforms in breadboarded amp and only with certain brands of tubes when I used this lower resistance value. I decided to err on the side of stability and not worry about inaudible differences in measurable parameters. If you're a natural tweaker, here's one place to play.

The selection of output tubes was an interesting project in itself. While waiting for my output transformers to arrive I set up a test jig using the breadboarded preamp-driver described above, a 450 volt bench supply and an output transformer salvaged from a junked Fisher 50A. And I mean literally "junked." I found what would have been a decent 50A tossed in a dumpster by someone cleaning out a garage full of so called electronic junk. Unfortunately dented and bent by its unceremonial flight, I managed to save the carcass by doing a quick dumpster dive before the trash truck hauled it away. From what I've heard, this maneuver is the principal means of parts acquisition by this magazine's publisher. [ed.— Just stay off *my* turf, punk.]

The tubes under test were connected as pentodes since the transformer had no screen taps, and I logged their relative power outputs at the onset of clipping as well as generated THD. A sampling of the tubes I tested follows:

Sylvania 5881	50 watts
Sovtek 6L6GC	36 watts
Sylvania 6550	66 watts
GE 1614 (metal 6L6)	41 watts
RCA 6CA7/EL34 (UK)	50 watts
GE 8417	68 watts
Telefunken 6CA7/EL34	47 watts

Parts List - Williamson Amp
(one channel)

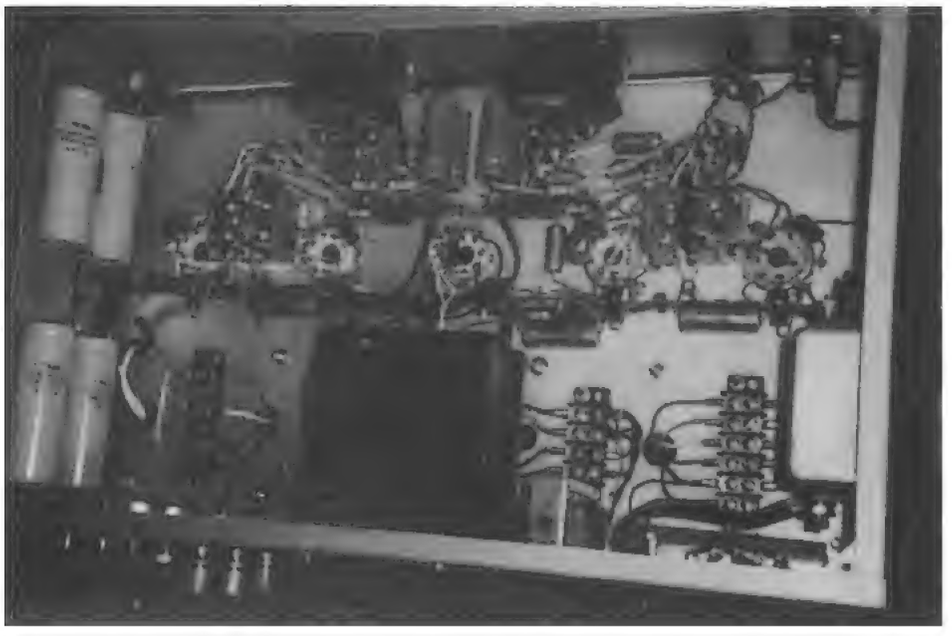
C1,C3 - 10uf/400V electrolytic or polypropylene
C2 - 820pf/300V mica or polystyrene
C4,C5 - .01 uf/500V "Vitamin Q" or polypropylene (matched to 1% or better)
C6,C7 - .25uf/500V "Vitamin Q" or polyprop. (matched to 1% or better)
C8,C9 - .1uf/100V tubular

Note: All resistors are metal film or metal oxide film unless otherwise noted. All resistors of like values are matched to within .5% with use of a DVM.

D1,D2 - 75V, 5W Zener diode for Ep of 500; 100V for plate voltages near 525
R1 - 47, ½W
R2 - 470, ½W
R3 - 3.92K (for 8Ω), 2.4K (for 4Ω), value is $1200\sqrt{outputZ}$ (Feedback resistor)
R4 - 47K, 3W
R5 - 4.7K, ½W
R6-R8 - 22K, 2W
R9,R10 - 220K, ½W
R11,12,14,17 - 100K, 3W
R13 - 950, ½W
R15,16 - 100K, ½W
R18,19 - 4.7K, ½W
R22 - 33K, 3W
M - 300mA DC panel meter
V1 - 6DJ8/6922
V2 - 12BH7A
V3 - 6CA7/EL34, 6550, 6L6GC, KT66, KT88, etc.
T1 - multimatch output xfmr screen taps at 40% to 50%

Parts List - Power Supply

T1 - 620VCT "surplus" power xfmr from H.P. scope, Similar rated xfmrs suitable
T2 - 115V to 6.3V filament xfmr
F1 - 5A fast blow
L1 - 4hy, 500mA filter choke
FL1 - surplus "Corcom" EMI filter, 10A rated
K1 - SPST power relay, 90VDC coil
K2 - Amperite thermal delay relay, 30 sec., 115V (115 NO 30)
D1-D5 - 2500 PIV 300mA diodes
C1-C4 - .005/3KV disc ceramic
C5,C12 - .47uf/200V "Vitamin Q"
C6-C9 - Mallory TCG capacitor, 180uf/350VDC
C10 - Mallory TCG capacitor, 21uf/250V
C11 - 35uf/250V electrolytic, low leakage type
R1 - 470K/2W carbon composition
R2-R6 - 47K/2W, 5% carbon composition
R7 - 2.2K/1/2W
R8 - 20k linear taper
R9 - 4.7K/1W carbon film
R10-R11 - 390/1W carbon film
R12 - 2K, 10W wirewound



Underside of amp

The winner and runner up in the battle of THD were the RCA 6CA7 and the Sovtek 6L6GC. I decided to use the 6CA7 for their great performance as well as the fact that I had acquired quite a few matched sets from shopping at flea markets during those dark days of the 70s when tubes were considered worthless by the unwashed masses. The selection of proper operating bias is interesting in itself. At the above 450 plate volts, the 6CA7s produced the best overall distortion at an idle current of about 110 mA per pair. My finished amplifier, on the other hand, has a plate voltage of around 530 volts. At this higher plate voltage, the best overall idle current setting was around 70 mA, using the previous value of over 100 mA caused surprisingly higher levels of THD at all output levels, and the tubes were really cooking at near max plate dissipation. Idle current set on the low side made for lower THD at higher power levels, conversely, higher idle current decreased distortion at low levels. It appears that optimum idle current is inversely proportional to applied plate voltage. Or, perhaps an optimum level of idle current differs between pentodes configured as such or in the UL mode of operation.

An unusual method of applying screen voltages to the tubes is used. Instead of the usual dropping resistors, I used a set of 5 Watt Zener diodes for special benefits: screen voltage is always held at or below manufacturer's recommended values regardless of screen current. Distortion products are materially lower because of the stiffer screen supply provided by Zener regulation—this is especially true for the EL-34 pentode with its wider ranging screen current than usual beam power tubes. And less screen voltage requires less bias voltage and therefore less peak signal voltage from the driver at max. output. Bench tests with EL-34s and 6550s in the output sockets confirmed an approx. 20% reduction in THD when the original dropping resistors were replaced by Zeners.

The use of a 10 to 20 ohm two watt resistor in the common cathode lead of the output tubes seemed to have a beneficial effect in lowering distortion products, but inconsistently so, being dependent on tube types. Again, you tweakers out there could play with this addition; I chose not to use this refinement in my own amplifier.

I made one final change to the original Williamson design. R12 and R17 provide an additional feedback loop directly around the output tubes. I found that with certain bias settings and certain brands and types of tubes, a tiny amount of crossover distortion became evident near maximum output. I'm uncertain as to the cause; it may have been a result of the interaction of the output transformer with the rest of the circuit, or by the tubes transitioning from a pure class A to class B operating level. The added feedback loops completely eliminated any trace of this problem and as a bonus improved overall THD.

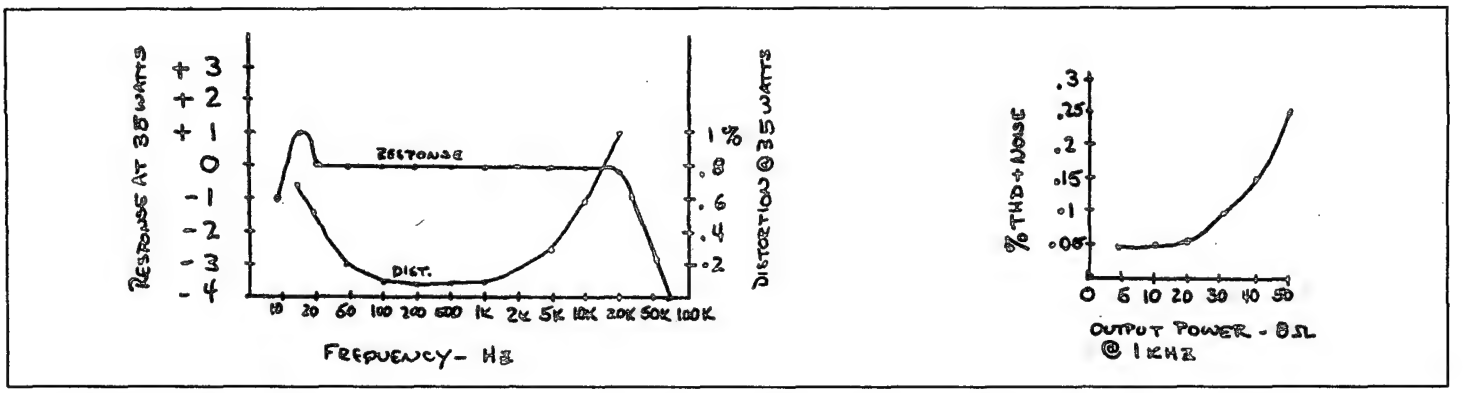
The decision-making process in the selection of output transformers was easy. I chose to use the Magnequest MQ-431 with screen taps at 50%. Unfortunately, I can't offer the results of comparison tests with other makes and models in my application, but the end results were pretty good. And I haven't heard anyone say that Mike makes a lousy sounding product!

Some comments on the chassis are in order. I originally thought a steel chassis was going to be required due to the weight of the top mounted iron. After looking over a number of catalogs I found that Premier Metal Products of Bronx, NY makes a line of 11" x 17" aluminum chassis substantially thicker than those made by Par and Bud. I was not disappointed; the finished product is very rigid and chassis flex isn't much more than would be experienced with a steel chassis.

Since the amplifier was destined for use in the family living quarters, I paid some attention to cosmetics. I had a metal finishing shop polish and apply a grained finish to the surfaces, then I had it hard clearcoat anodized. For a final touch I milled out a couple of chunks of dark hardwood, applied an oil finish and attached them to the chassis sides with the use of a couple of small wood-screws and some Liquid Nails construction adhesive. Several months later I added a small muffin fan and several ventilation holes in the bottom cover. This is important to prevent the buildup of appallingly high temperatures inside the chassis

As far as component selection goes, I didn't engage in what I perceive to be the excesses of anal retentive audio engineering. Most resistors are standard off-the-shelf metal film or metal oxide types matched to within .5% and operated at substantially below rated power. Based on the glowing reports here in *SP* for their sonic quality and proven reliability I used paper in oil capacitors for coupling in the signal path—Sprague Vitamin Qs and Clorinols. Again, these are run at a substantial voltage derating for longest life inside a hot chassis.

Internal chassis wiring was done exclusively with stranded silver plated teflon wire. Not for any alleged sonic benefits, but because it still looks good after being cooked during the soldering process. AC heater wiring was tightly twisted in an electric drill to minimize hum coupling into the signal path. Ceramic/silver contact mil surplus tube



sockets from my ham junkbox were employed throughout — because they look cool.

Since I can't run a shielded teflon insulated power cord all the way to the local power plant, I used a surplus Corcom double pi-section EMI filter to reduce line noise and rectifier destroying transients. A line cord cut off an old toaster was used for the rich sonic texture only a rubber appliance cord can provide.

A set of high voltage ceramic capacitors was used across the rectifier diodes to prevent a clicking type of noise that has been reported in the literature when a choke input power supply filter is employed. Apparently, this noise is created as the rectifiers go in and out of conduction during the AC cycle, and has been observed in both solid state and tube rectifier circuits.

An Amperite thermal delay relay that operates a second, heftier relay allows the tubes to warm up prior to the application of plate voltage. As a protective feature, I chose to use a surplus relay with a 90 VDC coil that will only operate and enable the high voltage supply if bias voltage is present. No bias, no B+. As it should be.

As per common practice, the 6.3 volt heater line is elevated to about 45 VDC via a voltage divider off the main B+ line to minimize hum. Don't omit C5, the heater line signal bypass capacitor; it's important in minimizing hum and noise.

PERFORMANCE

Aaah! The best part! I hooked up my bench equipment and thoroughly went over the completed amplifier. (For reference: H-P 200CD, Eico 378 generators, H-P 331A distortion analyzer and Tek 547 scope with 1A2 plug-in) Some of the results are shown graphically above.

Several of the specs come out better than initially expected. In addition to the remarkably flat response shown on the graph, the THD and IMD are far below the levels considered to be excellent in many competing designs and an order of magnitude better than commonly achieved in your typical SE amplifier. Certainly, if it is distortion products that explain in part an amplifier's "color", this amp should add no audible modifications of its own to the program source other than the sonic integration effects of the tubes and other components. Other measured specs are quite good: hum and noise output of .0005 volts RMS, giving a S/N ratio or dynamic range of 92 dB. Channel to channel gain matching is within .1 dB. When fed with a 5 KHz squarewave and driven to near full power, rise and fall times are close to 1.5 uF, an indication of both successfully minimizing stray circuit capacitance and even more so, the high quality of the Magnequest transformers.

So enough with scope jockeying! How's it sound?

As a point of reference, the rest of my system consists of a mid-1950s Knight AM-FM tuner (modified), an older Dual turntable using a Shure V15 type III cartridge, Rotel 955AX CD player, Hafler DH-110 preamp and a set of recently refoamed Large Advents. I put the Williamson in line and played some vinyl and CDs my wife and I were both familiar with — some Mozart piano, Sting, K.D. Lang, Stevie Ray, Lyle Mays, and Lyle Lovett. After listening for a while, my wife's first comment was, "How'd you get it to sound so good?" And indeed it did.

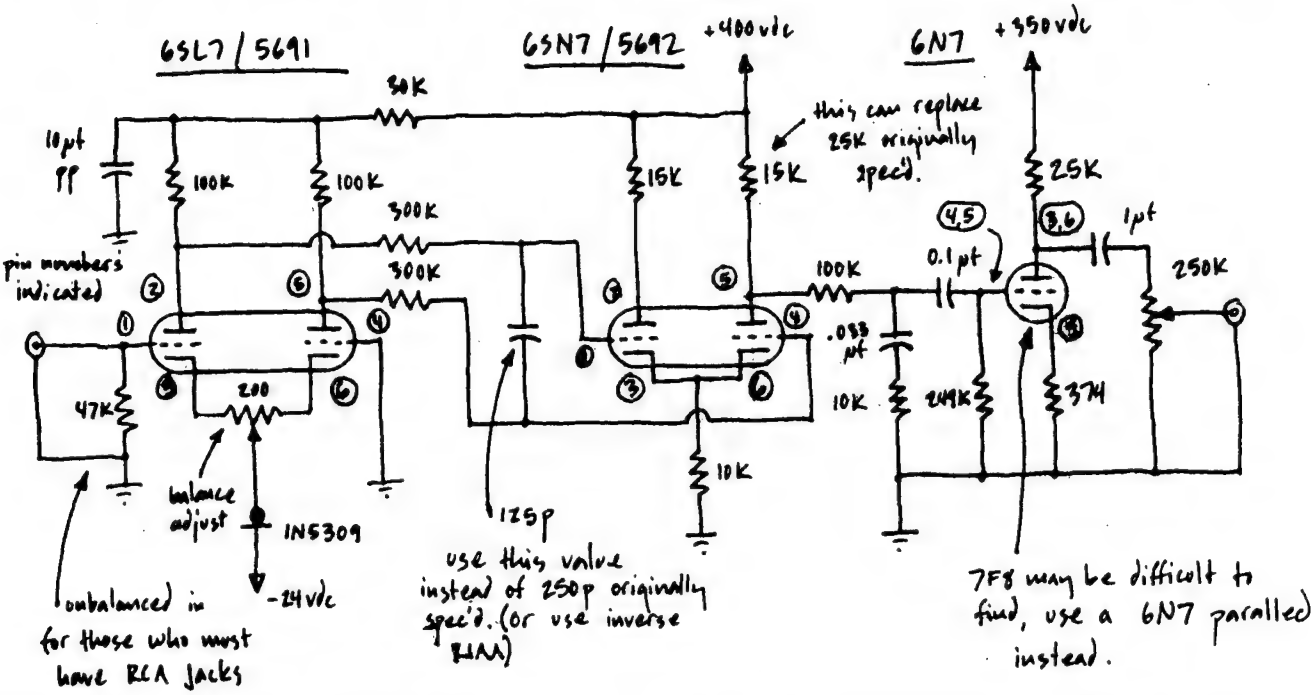
Now, I can't compare this amplifier with any other in terms one might use in wine-tasting, so I won't. The most immediately noticeable difference was on CDs, where that well known upper midrange harshness typical of digital program sources was largely gone. The overall texture was smooth, detailed, and tight — not tight in a restrictive sort of way, but more in the manner of a good Latin band where all the percussionists are perfectly in time and sync. In fact, a major positive point was its ability to accurately reproduce the sounds of percussion instruments, including drums and piano. Percussion? Piano? I was now able to clearly hear the sound of hammer on string, then the resulting instantaneous tone in a concert piano instead of just a tone appearing out of nowhere. You can hear the impact of stick on drum head, not a sound like a baseball bat on fiberglass outhouse. Much as smells can bring on a powerful sense of *deja vu*, I had the same feeling of remembrance at the subtle nuances of sound one only hears at a live performance. On some CDs, the playback apparatus seemed to tangibly disappear, leaving only the musicians. I don't claim to be a musical sophisticate, so I really can't describe it in more esoteric terms such as coloration and texture as I commonly see presented in the literature. Luscious? Gimme a break!

I will say that I was able to achieve what I considered a satisfying tonal texture with a minimal twist of the Hafler's tone controls. And I found that the louder I play this amp, the better it sounds., i.e. it cranks!

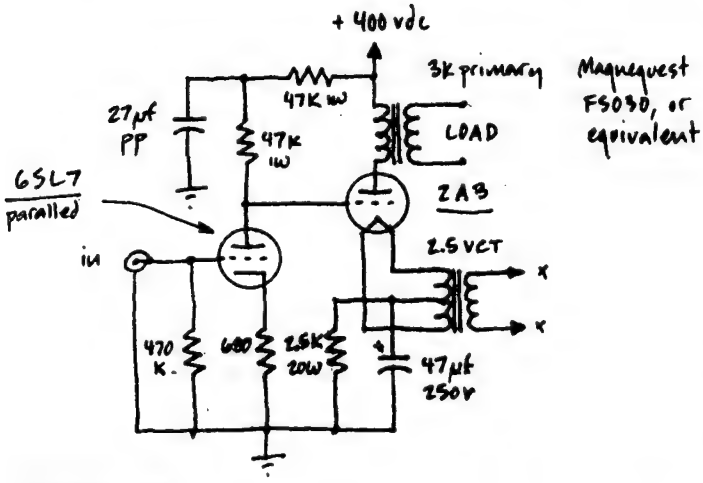
After some thought, I now believe that an amplifier's supersonic response and risetime are significant considerations in achieving excellent transient performance and realism, given a program source that's capable of delivering it. In other words, it takes a darn "fast" amplifier in terms of risetime to accurately reproduce the sound of a hammer striking a metal plate, and this Williamson delivers.

So, I've joined the ranks of those thousands who over the years have duplicated this classic design and are eminently satisfied with the results. You might be too.

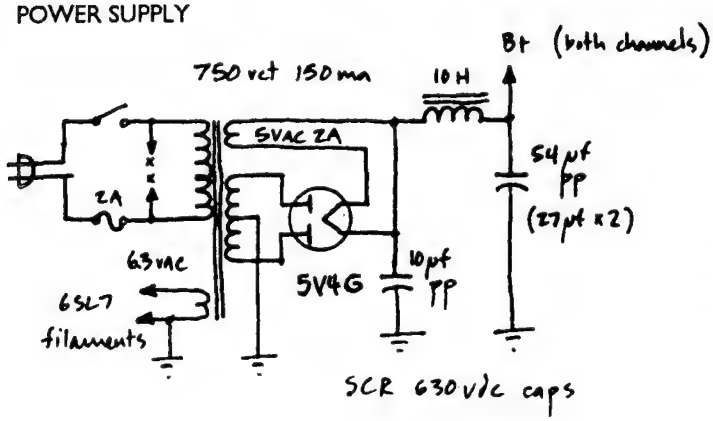
SIREN SONG PREAMPLIFIER- MODS &TWEAKS



MORRISON *MICRO* 3.5W TRIODE AMP



POWER SUPPLY



Thanks to reader communication and insights gained from continuing experimentation, here are a few updates and tweaks for the Siren Song preamp circuit published in SP #3.

I included a balance control in the cathode of the first differential stage. Adjust for equal plate voltages on the 6SN7/5692. This will get you real close to AC balance with a minimum of hassle and test equipment. You could switch to a 1N5311 (3.6 ma current source) for a *small* improvement.

A few changes are proposed in the RIAA network to tighten up the equalization. If you're really anal about absolute phono EQ perfection, use an inverse RIAA network to tune out any deviation from the ideal curve. Results with the above changes will be close enough for the average hedonist.

Several readers wrote that 7F8 tubes can be difficult to find. Also, after testing a few dozen 7F8s in the circuit, I found that a few specimens went into unprovoked oscillation. I now suggest that you use a 6N7 instead of the 7F8. The 6N7 is a great tube which is both common and inexpensive. I'm surprised it isn't used more in modern audio. If you can locate a pair of 5694s, a classy industrial-grade relative of the 6N7, I highly recommend that you give them a listen.

The *Micro* 3.5 W amp is as simple as it looks. It's a perfect partner for your Siren. Build it as proposed and it will work great. Given the ultra-simple direct coupled signal path, the output trans will determine the ultimate sonic performance of this amp. Excellent iron = excellent results. Build it and enjoy!!

J.C. Morrison
Fi, NYC

Casual Reactions



by Herb Reichert, Eddy Electric

ULTRA FI HORN SYSTEMS

The vast majority of American audiophiles that I meet are unfamiliar with the sound that a good horn system provides. In fact, most seem to believe that *there is no such thing* as a *good* horn. Most have heard only damaged, overdriven, and poorly installed P.A. horns at the stadium or disco. A few remember hearing vintage Electro-Voice systems or Klipschorns driven by early transistor or aging, out of spec tube amps. We have all had bad horn experiences and nothing is as painful as a really awful horn system. If you have only heard nasty horns, you might find it hard to believe that a good horn system can be the best speaker PERIOD.

TRIODEMANIA 93

Samedi 15 mai 93

de 14 h à 19 h



— SUN AUDIO
— AMPLIFICATEUR 300B LEGEND (transfo Partridge)
— Réalisations Amateurs (PX25 - 845 - VT52)

En écoute sur le prodigieux système ONKEN-WESTERN

Only a small handful of American enthusiasts have heard the kind of carefully engineered and lovingly installed triode-powered horn systems that the French and Japanese have been listening to. I have been lucky; my French and Japanese friends have helped me to develop a system of this kind. Building it was one of my most rewarding audio projects ever.

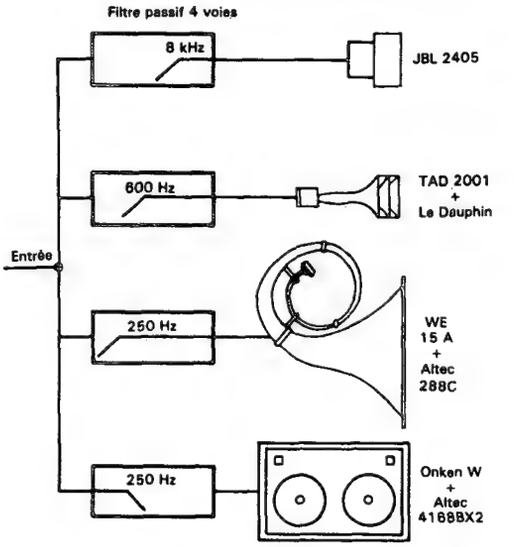
Although there is a lot of room for the individual touch in design of horn systems, a few classic components have achieved worldwide recognition. A typical Asian or European horn system consists of either an Onken or Altec V.O.T. bass cabinet with Altec 515, 416, or 414 drivers. These two low frequency systems are of such quality that they provide the foundation for nearly all the "ultra-fi" horn systems in Asia and France.

The "Petite Onken" enclosure for the Altec 414 12-incher is very popular in smaller European homes. At 40 Hz, Jean Hiraga measures .8% THD @ 100 dB/1m with this combination. It measures only 34"h x 18"d x 25"w. A larger Onken box for 15" woofers is also very popular in Europe and Japan.

The V.O.T. based systems have less bass extension but play with more veracity and power in the 100-500 Hz band and are therefore most favored by lovers of large orchestral works.

There is a much wider range of choices for quality midrange. The Altec 511/811 horns with appropriate compression drivers or Altec multicellular horns with 288 drivers are universally popular entry level midranges. Everybody has their favorite tweaks for these old stand-bys. Well financed triode maniacs in France favor the Onken SC-500 sand-filled wood horn or its look-alike, "Le Dauphin". These are used with the TAD 2001 or Onken OS-500 compression drivers. In Japan, the TAD wood horns or home-made equivalents are commonly used with a wide variety of TAD, Altec, WE, or JBL drivers. Here again, the best systems tend towards wood horns with compression drivers.

Système Onken/Western/TAD/JBL



Triodemania '93 hosted by *La Maison de L'Audiophile* in Paris—Onken W enclosure for 2 Altec fifteens, Western Electric 15A wooden "ram's horn" with Altec 288C compression-drivers for the midbass, and a Onken-style wooden horn for the midrange. *Incroyable!*

Audiophile horn systems are usually three-way setups. Above 5000 Hz, the rich guys use the renowned Onken OS-5000 and everybody else does the best they can. The French prefer the JBL 2405 "slot" tweeter and Japanese like tweeters by Fostex and Gauss.

The Europeans prefer passive crossovers and one pair of "Legend" 300B amps or other fine triode amps, while the Japanese universally favor bi- or tri-amplification.

None of this equipment is compact or inexpensive. An all-Onken system could easily cost $10,000! But the build quality and durability are of the highest standard and the level of sonic refinement such systems provide is impossible to achieve otherwise.

It takes love, patience, and cash to build one of these exotic "ultra-fi" systems. Unless you've heard one, you are going to have to trust me when I tell you that these systems do not sound like ANY horns most Americans have heard. In my experience, these combinations can be more vivid, more detailed, far more dynamic, and less easily confused than the typical U.S. high-end setups. This is the type of system for which the Edgar midrange horns are designed.



Bruce Edgar's 250 Hz tractrix horn for the Dynaudio D-54 driver.
Measures only 11" H X 21" W X 13" L

THE E-HORN

When I drank, I couldn't keep a secret at all. Now, after eight years without a drop, I can only keep a secret if it is totally boring. So, I have to tell you that a scientist from Torrance, CA has made some break-through discoveries that could radically change the reputation of the horn in American "high-end" audio -- at least for those of us fortunate enough to live in something larger than an Airstream trailer or a NYC "studio" apartment.

Bruce Edgar is a contributing editor for *Speaker Builder* and a space scientist by day. He has been working on refined horn designs for a number of years. His current portfolio includes five midrange horns that take the horn out of pro-sound, past hi-fi, and on to the world of "ultra-fi." They are cone-driven horns made from wood which are based on a Tractrix expansion, the only flare which provides a spherical wavefront.

Each of the five horns was designed around a specific, commonly available cone or dome driver from companies like Dynaudio, Focal and Polydax. The driver is fastened onto the back of the wood horn. The complete units have sensitivities in the 100-105 dB/watt/meter range. They are four octave devices, covering the 400-5000 Hz band. They are remarkably small for their LF cutoff rating. One 300 Hz horn I have on hand is only 18" wide and 11" deep.

Dr. Edgar's philosophy is "Ultra-fi for the people." He is a supporter of home construction and a hobby builder himself. Aside from writing for Speaker Builder, he is often involved with DIY speaker contests and the like. The Edgarhorn is meant as a DIY project, although Bruce does sell some horns he makes in his garage wood shop at very reasonable prices.

With people like Bruce Edgar supporting creative home audio, the real state of the art is in the domain of the experimenter and not in a color ad in an audio magazine.

The sound from these wood horns is so smooth, detailed, and undistorted that when a friend and I first listened we thought something was wrong. We both kept looking at each other saying, "This is very strange." However, as the piano player rolled back and forth past middle-C we looked at each other and froze. It was startling—and right!

At this point we both realized it was not the Edgar horn that was strange, but every other speaker we had heard to date. Our initial reaction was that this was RIGHT and we both knew it. The distortion we have come to accept from loudspeakers has been reduced in the Edgarhorn to such low levels that, after experiencing music through them, other audiophile and professional speakers sound fuzzy, grainy, and opaque in comparison.

The two most outstanding traits of this driver are its complete lack of artificial character and its grainless, dynamic presentation. These are rare qualities, found only in the very best loudspeakers. Additionally, these speakers require only a few tube watts to play ANY type of music at extremely high SPLs. What more do you ask?

Compared to the IRS-Vs, the Divas, and several Euro-style ultra-fi systems I got to hear around New York, the Edgarhorn presents music in a smoother, more relaxed, and "cleaner" fashion. With the Edgarhorn and a pair of homemade Onken or recycled Altec V.O.T. bass modules and a JBL 2405 or Polydax PR-120 tweeter, create a world class loudspeaker system at a small fraction of the usual cost. A clever music lover who is handy with a saw and screwdriver could conceivably build a IRS-V beater and hang out with the Ultra-fi horn crowd for under $2000 !

Where's the caveat? My only disappointment is that the Rolling Stones sounded a lot more 'rough and ready' on my Altec 1005/288Cs. All the little peaks and ringing in these horns add some excitement to live rock recordings that the Edgar wood horns do not. But that's a special case., In general, the Edgars throw a gentle, even light on the performance that just makes you want to keep on listening. It appears that a cone driven horn may have advantages over a compression driver for small room systems. Listener fatigue is simply not an issue.

So for now, I tell you these horns are wonderful, perhaps as good as it gets, but you can't just substitute them for your present midrange in most systems. My early experiments have shown that because they are horns, because they are sensitive (efficient), and because they are very low distortion, creating a complete system or integrating them into an existing system can be challenging. In short, it's hard to find a low end that is good enough in the ways that the Edgarhorn is good.

Finding six more octaves of this quality is what I hope to do myself. Dr. Edgar's low frequency horn designs, the "Monolith" 40-400 Hz horn and the 50 Hz "Show" horn, might be the ticket. Stay tuned for a detailed report on the "Show" horn and a bi-amped Onken/Edgarhorn system I'm building.

If I have succeeded in developing a "high fever" in some of my readers, I am sure you will be writing Dr. Edgar and experimenting without waiting for me—here are a few tips worthy of consideration.

First, if you choose a direct radiator or Onken bass enclosure: BI-AMP. Padding the mid-horn down 6-9 dB to match the efficiency of these bass units makes the speaker sound dull and lifeless. The same amount of padding makes compression type drivers sound bright, grainy and harsh.

If you use a passive filter, use only a first-order device. The mechanical rolloff of the horn on the low end will give you a steeper effective slope on the bottom and cone mass induced roll off will take care of low pass on the top end. A high quality series capacitor is all the crossover you should need with the Edgar mid. Use another series cap for the tweeter and you're in business.

If you don't want to bi-amp, use a horn below 500 Hz. One of Dr. Edgar's other designs might be perfect. I'm using an Altec 825 (A-7 low end) with 515s in combination with the Edgar-horn in my system.

One last note; don't just pile this stuff up. If you want to experience the tremendous focus and detail of this driver you must tie them down and damp them. I recommend separate, sand-filled enclosures for the mid and high units. I then recommend mounting the mid and high units on separate spiked and sand-filled stands. This creates a three-piece full range speaker with exceptional mechanical isolation that the truly fevered can arrange and "time-align" to taste.

If you're traveling along the path outlined in this article, please write me care of *SP* and share your discoveries.

References:

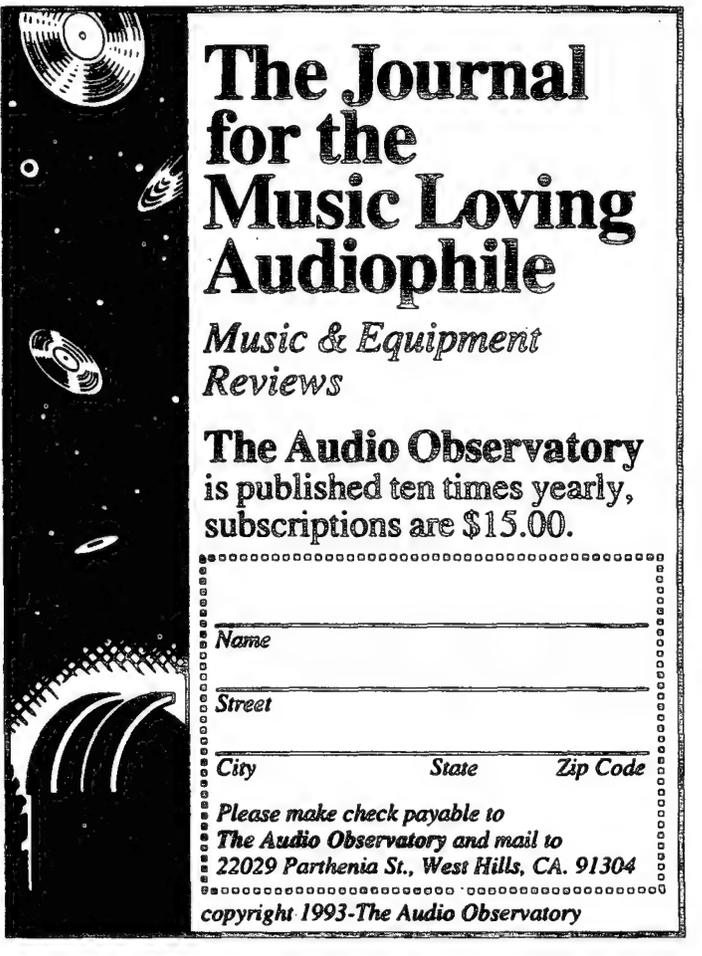
Speaker Builder, One/1986, "Edgar's Midrange Horn"
Speaker Builder, Two/1990, "Bruce Edgar's Show Horn"
Speaker Builder (forthcoming) "The Monolith Horn"
Hiraga, Jean *"Les Haut-Parleurs"*, Editions Frequences, Paris. Distributed by Eyrolles, 61 Blvd. St. Germain, 75240 Paris, France.

Contact: Bruce Edgar, PO Box 1515, Redondo Beach, CA 90278

ed. note - It's true. The Edgarhorn is indeed special. After a few weeks listening to a pair of custom E-horns designed to work with my favorite 8" cones—Altec 755As and Lowther PM-6s, what was left of my Altec and WE theater gear collection went up for sale. Sure the Edgarhorns require care in set up but something like an Altec horn system is *much* more challenging to get right in a smallish room. At least, I personally never got a compression driver system with metal horns tweaked to the point where I was 100% happy. With the Onken/416A LF system and a Gauss pro tweeter, I had *la musique* after only two days of playing around with the E-horn—with no machine work or heavy lifting required.

The Edgarhorn doesn't sound like a speaker at all—at least not like any other speaker I ever heard. The E-horn is destined to become the reference standard for midrange purity. Although I don't have much patience for whining Audiophile criticism, I must admit that it is unsettling to listen to a midrange that doesn't provide anything to complain about.

I am really glad that I tried Edgar's midrange horn. The only problem is that now I strongly desire horn loading down to at least 100 Hz. Hey, Bruce. . . where's my *mid-bass* horn?



CLASSIC DESIGNS

THE ONKEN ENCLOSURE

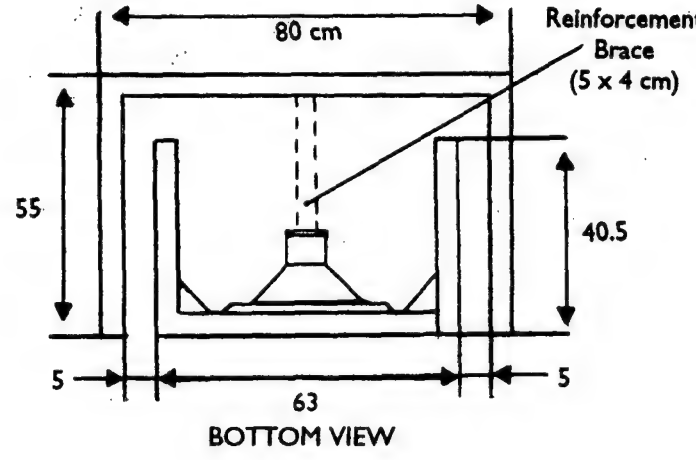
"Onken" is not exactly a household name among Western audiophiles. But for those in the know it represents one of the ultimate refinements in modern audio. Despite their rarity and great expense, the Onken transducers are among the few modern speakers that have achieved cult status worldwide.

Founder Eijiro Koïzumi brought the finely crafted Onken transducers onto the market in Japan in the early Seventies. The Onken drivers and speaker enclosures, designed in consultation with an acoustics professor from Tokyo University, received wide critical acclaim among advanced Japanese audiomaniacs. Unlike the many Japanese super-mania creations which go completely unrecognized outside the local audio community, Onken was to enjoy an international destiny.

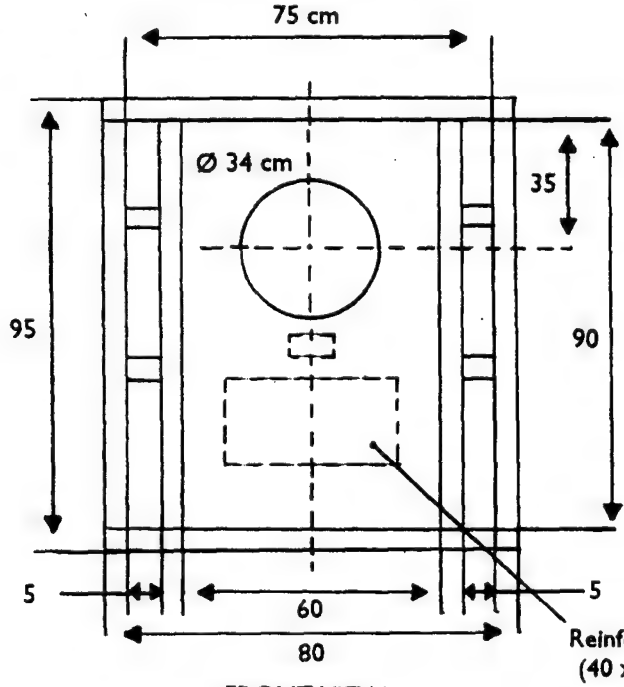
The man responsible for the wide diffusion of the Onken system was Jean Hiraga, a Franco-Japanese engineer and journalist who wrote for *Revue du Son* and edited the pioneering journal *L'Audiophile* from its inception in 1977.

Hiraga lived and worked in Japan as a correspondent for *Revue du Son* during the era of the ascent of the Onken. His role was to act as a broker between the Japanese and French audio cultures. He was the first and most influential contemporary spokesman for triode amplifiers and horn speakers in the Western Hemisphere.

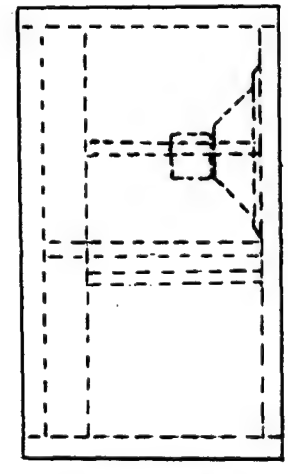
In one of the premiere issues, *L'Audiophile* promoted the Onken bass enclosure, a design derived from a Jensen design of 1938, as an answer to the difficult question of what to use for a low end with high resolution horn midrange speakers.



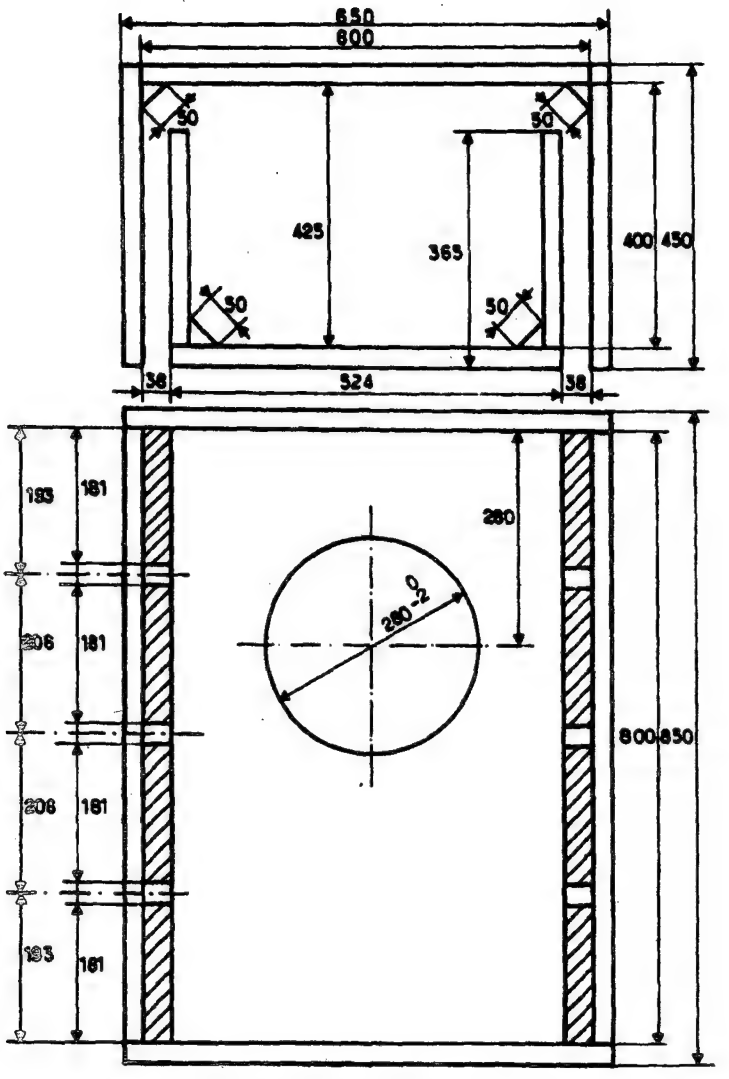
BOTTOM VIEW



FRONT VIEW


SIDE VIEW

The classic ONKEN enclosure for the Altec 416-8B



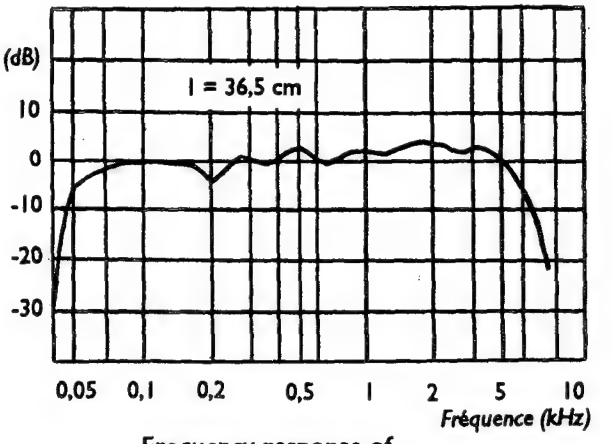
The "Petite Onken" for the Altec 414-8B.
A front-to-back brace should be
added as in the 15" enclosure

Finding a quality low end for your horn system can be a real challenge, as many independent experimenters have discovered and Hiraga had one solution. Based on listening tests, *L'Audiophile* suggested the Altec 416-8B as a suitable replacement for the scarce and expensive Onken woofer in the original 15" bass cabinet.

In September 1982, L'Audiophile published the plans for a smaller Onken enclosure designed by Koïzumi in 1976. It became very popular in Europe, as it had in Japan, due to its reduced size and for its ease of setup and tuning relative to its big brother. This smaller Onken box is known as the "Petite Onken" in France and by its original name "IP Ultra-Bass" in Japan. The 12 inch Altec 414-8B was used in this cabinet. Subjective and measured performance is generally on par with the larger Onken.

During the Eighties, the French loudspeaker manufacturer Focal recommended Onken-derived enclosures for several of their LF drivers, including the 10C01. The "Onken-Mahul" Focal bass system differed from the classic Onken in that it had ports on all four sides of the box, rather than only on the sides. The unique Focal plaster "Egg" two-way system was utilized as an HF system with the Onken-Mahul box.

Thanks to construction plans published in *L'Audiophile*, the Onken designs were and are widely reproduced by advanced hobbyists and craftsmen who cater to the audiophile elite. As always, selection of materials is a critical aspect of the art of audio design and in this regard there is no equivalent to the original Onken. The Japanese version used exotic pressure treated one-inch plywood and carefully selected long-fiber wool for damping. The *L'Audiophile* articles recommend one inch (2.5 cm) marine-grade plywood and argue that wool stuffing is indeed the best choice.



Frequency response of
Petite Onken/Altec 414-8B

If you choose to recreate the Onken box, the finishing touches are up to you. However, between the French and the Japanese, all likely variations have been tried. *L'Audiophile* suggests building these designs "*sans aucune modification*"— probably well founded advice. By all means, rear mount the driver; do not blindly follow conventional audiophile wisdom and attach the driver from the front!!

The Onken enclosure is renowned for its natural, articulate, and detailed low end. Although there are bass systems which have greater extension and bass horns with more "slam", the Onken ranks high in terms of subtlety and finesse. In terms of pedigree and mystique, Onken is in a class of its own among modern loudspeaker systems.

Analog Control Panel IV

A line level preamp with direct coupled servo output

by Gordon Rankin, Wavelength Audio

Of all the equipment that I go through, the pre-amplifier is the most stable component in the chain. Perhaps this is because a pre-amplifier requires less maintenance, but it seems that after I find one I like it stays there. Now that we have broken out of a constant loop of amplifier projects (thanks to Vinny Gallo), maybe I can finish that line level pre-amplifier everyone has been hounding me for since *SP #1*.

Line level preamps have been gaining in popularity over the past decade because you can get great digital performance at reduced cost over a phono-equipped unit. If, like me, you're still into vinyl, a separate phono stage such as J.C. Morrison's Siren Song from *SP #3* can easily be added if black disc playing capability is desired. I love my Linn but I am also totally into digital. My modified CD player and my DAT get as much airtime as my turntable.

I call this pre-amplifier "The Analog Control Panel IV." It's "IV" because it is my fourth commercial preamp effort and there are coincidentally four tubes in the circuit. This design is based on feedback and suggestions from numerous individuals and draws on various cool ideas I have been tinkering with for the past few years.

My design criteria were as follows: The unit should be easy to build with generally available parts. It should be simple enough to build without a math degree, (. . .not that math is boring or anything) but novel enough to strike interest in heavy duty technotypes.

Reader Mike Somers recently asked me why I never give up any of my hot design secrets in print. Well, okay Mike, for added excitement I will reveal one of my favorite design tricks—my servo controlled DC coupled cathode follower strategy.

We are going to break this project up into two articles. This one will deal with the electronics of the gain/buffer stage and in the next installment we will look at switching and volume control implementation.

For maximum versatility, we will include a "direct input" which skips the gain stage and selector switch, going directly to the input of the buffer. So if your digital source is already riding high on gain, you can choose the direct link for shortest signal path. You can then use the gain stage to match the level of your tuner or other lower output source to your digital source level.

GAIN STAGE

I have been searching for a good single stage non-inverting gain block for some time. The differential amplifier is well suited for the task. A nice feature of this circuit is its minimal parts count and availability of both in-phase and out of phase output at the same level.

The gain stage of this project is a simple differential amp using the 6922, a boss version of the perennial favorite 6DJ8. The Sovtek 6922 is a fine high transconductance audio tube, try it! The cathodes are fed from a current source based on a MPSA05 transistor. Each side of the diff amp runs at 4 mA so the current source is set to deliver 8 mA. The calculated gain of each section is just over 10, just what we were looking for for 20 dB. Actual gain is around 12.5 for the Sovtek 6922 and 11.2 for the Sylvania 7308.

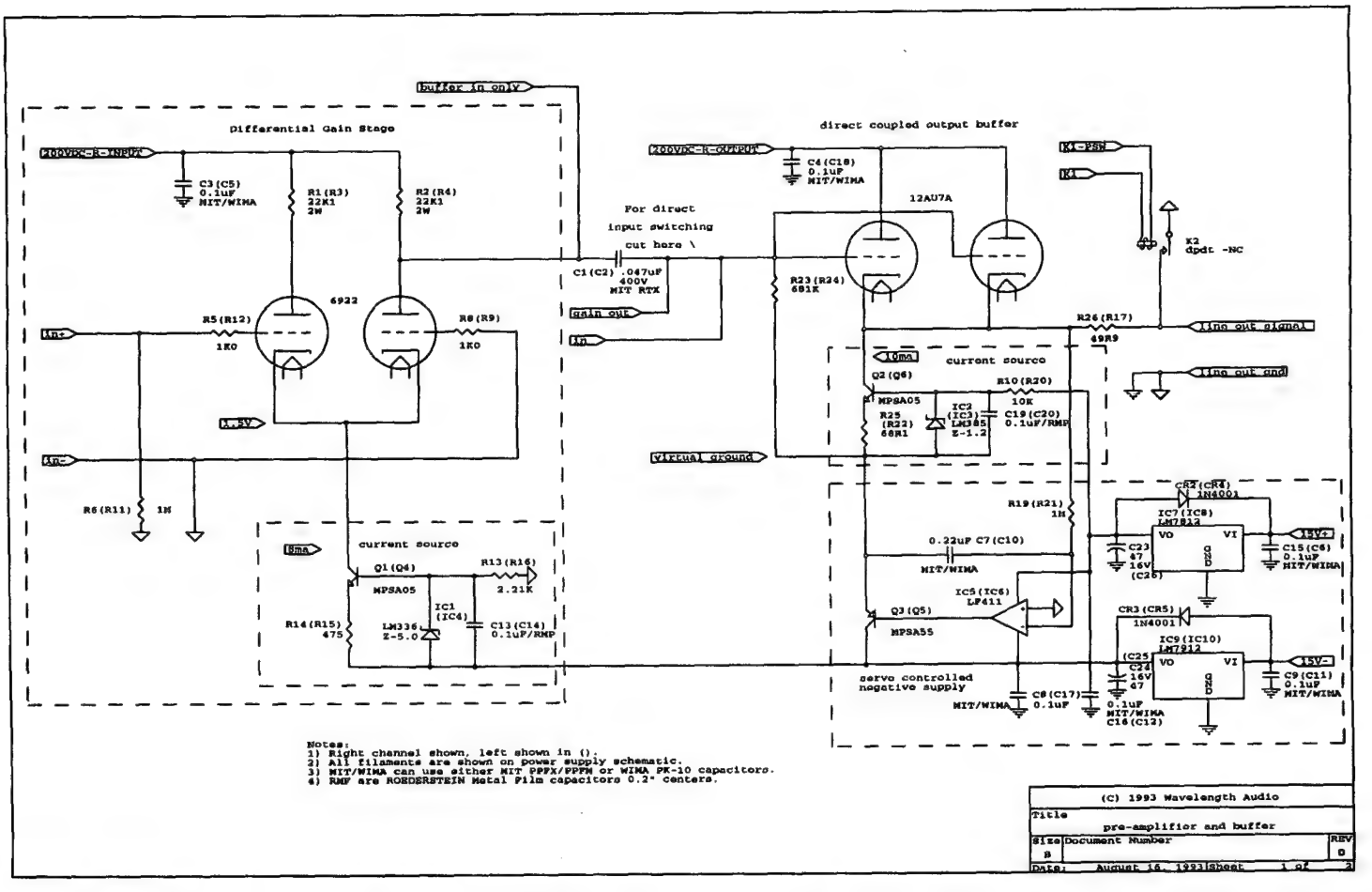
A differential stage gives us both inverting and non inverting outputs. I use the non-inverting output. Many high end units invert polarity, perhaps because designers wish to minimize the number of gain stages. I have an ethical problem with this. *Maybe* there is no sonic difference, *but*. . .

As J.C. Morrison noted in *SP #3*, the power supply interface of the differential is optimal because each half of the differential draws opposite current. We will use separate supplies for input and output buffer in each channel for better regulation and isolation. Cool so far, but wait till you see the buffer/output section.

When I first got started with Wavelength Audio, I was strictly solid state. I didn't really "find myself" however until I converted to tubes. Dedicated tube purists might object that the output stage has some solid state principles in it. However the audio path only traverses the 6922 and the 12AU7. We're using solid state here for control circuitry for convenience. We could do all this with tubes at a great increase in cost and complexity with no operational advantages whatsoever. Solid state devices are a great resource for many applications and I don't hesitate to use them where appropriate.

THE BUFFER

A cathode follower was chosen as a buffer because it requires only a single stage, it has good output capabilities, and the gain is close to one—0.95 in this instance. The trick to getting a



cathode follower to sound good is simple—the cathode must see an extremely high impedance so that it only drives the load and not the cathode resistor. A current source will give us the high impedance we want. Also, as the cathode impedance increases the gain approaches unity.

The main problem I have with tube pre-amplifiers is those huge DC blocking caps required on the output of the cathode follower section. I think it was Walt Jung who argued that "the best capacitor is no capacitor at all." *NO* capacitor can get complicated but many designers recognize that the lower the value of the cap, the better the sound. Output caps on cathode followers usually need to be high value units.

We are using capacitor coupling on the input to the buffer, but since the input impedance is extremely high (up to 2.2M can be used as a grid resistance for the 12AU7A), we can use a good sounding small cap. Let's keep the grid resistance to 681K for the paralleled sections and use a 0.047 uF cap. If you don't need flat response to 5 Hz, a 0.033 uF cap will get you down to -3 dB @ 7.1 Hz.

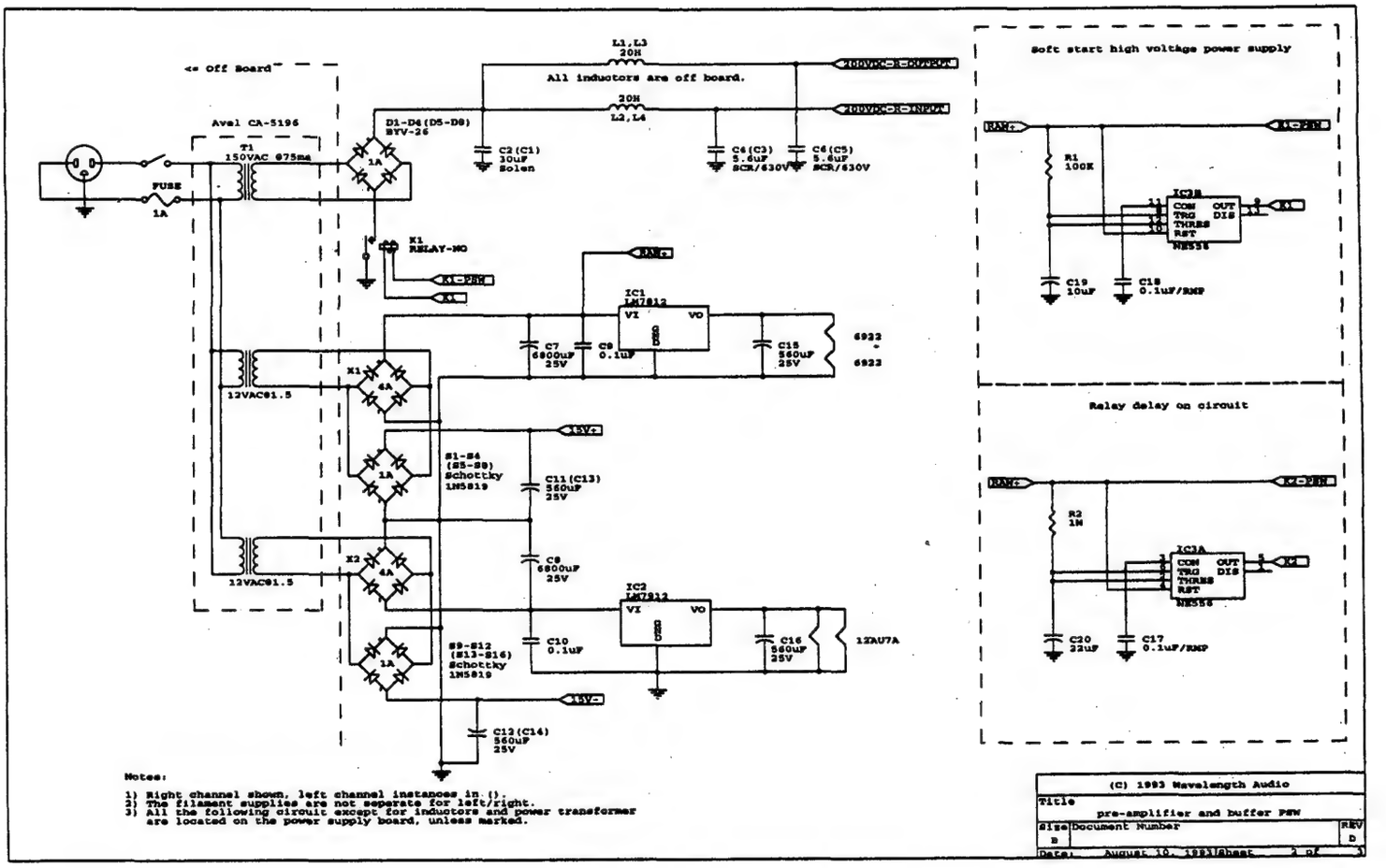
Instead of using a large DC blocking cap at the output, we can employ my trusty servo design. I used servos in several of my discrete transistor/FET circuits to correct for zero DC offset instead of using a big nasty cap to block DC and the sonic results were excellent —so let's try it here.

A servo is simply an error amplifier. The voltage seen on the input is subtracted from the reference (ground in this instance) and applied on the output to compensate for the error. The performance of a servo is further enhanced by a low pass filter to limit the frequency range to approximately DC. Using this technology, we can keep DC on the output way down in the nanovolt range.

I chose an LF411 for the servo because of its extremely low offset voltage, high input impedance, and low drift. One method of direct coupling is to control the negative grid bias through the servo. However, this approach would require a really high grade power supply since variations in the supply voltage can show up on the grid and act like signal.

A more simple way of doing it is to bring the cathode down to zero volts. We will use a negative servo as shown on the schematic. The MPSA55 in the servo provides an even lower output impedance than the already low output Z of the LF411. The grid resistor of the 12AU7A and the current source are attached to a "virtual ground."

The power supply board also uses an NE556 timer to delay the high voltage and to clamp the output (using relay K2) until the servo and the tubes warm up to prevent pops at turn on. When K2 closes at power up, the servo actively corrects for DC offset on the output. When the system is warmed up, the relay opens and music appears at the output. The servo is great because there are no adjustments to make. Plug in a



different brand of 12AU7 and off you go—no changes, no problems. The servo will automatically correct for any variety of 12AU7A within a bias voltage range of -5 to -10V (-7.5V typical, -8.5 for the Gold Dragon)

PCBs

That is, Printed Circuit Boards, not the deadly stuff in oil caps. It might be true that the best of all possible worlds is point-to-point wiring. If you plan on building this preamp from scratch, go ahead and wire it that way. However, over the years there have been many great sounding products on PCBs. Using a PC board greatly simplifies construction and with proper attention to layout and design, the end results can be excellent.

I lay out my boards using PC software. The important thing here is to find a package that will handle curves well. The performance of a board can be compromised by squared off traces. You want curves that have either rounded corners or trimmed to 45 degree angles, otherwise radiation can become a problem. A square corner will radiate at the tip, causing bleed over and crosstalk with other traces. The size of the traces is also a consideration. For analog circuits, the trace should be at least 25 mils wide. The PCBs for this project use 50 mil traces for the signal and control circuits and 100 mils for the filament leads. I use two layer boards so I can layout all the components without breaking up the traces with jumpers.

The circuit is split into a power supply board and a signal board. This is for isolation and to provide the option of housing the power supply in a separate cabinet if desired. The power supply board carries all supply components except the power transformer and inductors. The signal board holds all of the gain and buffer components and the regulated +/- 12 V supply.

The signal board starts at the front with the 6922 gain stage and works its way back to the output section. The board is split down the center with a Roger's Q-strip for a quasi-star ground configuration. The strip has two conductors of high quality copper. There are takeoff points for signal ground and power supply ground. They are joined at only one point at the ground connection from the power supply.

POWER SUPPLY

The power supply is "dual mono" all the way back to the power transformer, which is shared by both channels. Two power transformers could have been used, I suppose, but for a reasonable economy measure I choose to employ only one. The four legs of the HV supply are very well decoupled after the shared transformer.

The power supply uses all fast recovery diodes for rectification—except in the filament supplies which use full wave bridges. The diodes of choice for the low voltage are Schottky rectifiers and for the high voltage, fast recovery epitaxial diodes.

Let's look at the power supply in three parts: filament supply, low voltage and high voltage.

Filament Supply
In pre-amplifiers, a nice regulated DC supply for the filaments will keep the noise floor down on the gain and output stages. The 6922 has an extremely low noise floor with a clean DC heater supply. A 4A bridge is used to rectify the AC input voltage, which is fed to a 6800 mF cap followed by plus and minus 12V regulators. The plus side runs the 12AU7A filaments in parallel and the minus 12V side is used to heat the 6922s.

Low Voltage
The AC is rectified by Schottky diodes and filtered on the power supply board. Additional filtering and regulation is provided on the signal board. The idea of putting the LV regulators on the signal board is to avoid long leads between the regulator and the circuit it powers for low noise and lowest output impedance. Since current demand is low (about 25 mA), we can use LM78L12 and LM79L12 regulators. They are bypassed with high frequency capacitors. The LM7X12s are followed by the current sources and the servo supplies so they will work fine here.

High Voltage
The AC input is rectified by fast recovery epitaxial diodes of the BYV variety (available from General Instruments and Philips—Digi-key stocks Philips). The supply turn-on is delayed for 20 seconds so that the heaters will have time to heat the tubes. This will prevent cathode stripping and promote longer life for the tubes. The output of the discrete rectifier bridge goes to a pi network consisting of a 20 mF polypropylene cap, a 20 H choke, and a 5.6 mF poly cap. Two such filter networks are provided for each channel: one for the 6922 stage and one for the output stage. The supply leads are bypassed at the signal board with high frequency film capacitors.

Fast Diodes
Before I got started on a project with (count them!) 24 diodes, I did some investigation to find the right parts. Corey Greenberg's second *Stereophile* article on the BUF-03 buffer generated a lot of hoopla on "fast" diodes. I sought some advice from John Schlesiner of Precision Audio, a diode design expert by trade. He claims that the reason that fast recovery diodes provide better performance is their ability to 'disconnect', providing better isolation between power transformer and filter capacitor. Ideally, the rectifier should conduct to bring the cap reservoir up to voltage initially, then it just tops off the potential drained from the supply caps each cycle. The faster the diode the better it can connect and disconnect from the circuit.

Schottky diodes have basically zero reverse recovery time and work great for low voltage rectification. The problem is that they only come in low voltages (60 V max.) so we can't use them for the high voltage section. For HV applications, fast recovery epitaxial diodes are the best available. The BYV variety switch faster than 35ns, much faster than the standard 1N4004 variety.

This circuit will provide over 5 V RMS at the output and an output impedance at 1kHz (sine wave) of 350 ohms. Bandwidth is from 10 Hz to over 100 kHz (-1dB).

For listening tests, I wired the unit up direct with a 250K ALPS pot and a single set of inputs. I used my DAT as a D/A converter, a pair of Wavelength Audio Cardinal Mk.II 300B SE amps, and the Taddeo Arpeggio loudspeakers. I also added Tony Taddeo's excellent Digital Antidote to the audio chain toward the end of my preamp audition program and I found that it provided an apparent increase in resolution.

Anyone who knows me will tell you that I'm not inclined to talk about the way equipment sounds in poetic terms. In short, this preamp has the sonic attributes one expects from a quality tube unit in terms of imaging and soundstaging. Thanks to the direct coupled output it provides the quick and punchy bass of a great solid state unit without the dry or harsh character that often plagues non-tube electronics.

SOURCES
Analog Control Panel IV kits and parts:
Michael Percy
Box 526, Inverness, CA 94937
415-669-7181 voice
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ALTEC "Voice Of The Theater" Speakers For Hi-Fi

by Jeff Markwart and John Tucker

Several years ago, while auditioning components for an overall system upgrade, Bill Fisher of Friendswood, Texas, suggested that I consider horn loaded speakers. The following weekend, he gave me a demo of his classic Altec Lansing A7-500W-1 Magnificents. The Magnificents are a furniture cabinet version of the A7 small "Voice of the Theater" system with a 500 Hz horn.

It was immediately apparent that these imposing boxes did a number of things very well compared to the majority of speakers I had been evaluating. Positive characteristics included:

- huge, effortless dynamics
- fast, controlled midrange transient response
- dramatic presence
- midrange clarity
- natural, open sounding bass
- high efficiency

I was hooked. Before long there was a pair of A7-500 Utilities in my front room running on a pair of 6B4-G push-pull triode monos I built. John Tucker stopped by for a listen and soon Altecs appeared at his house also. Over time, however, John and I became aware of a number of shortcomings inherent in the stock A7. These included:

- midrange and treble distortion on program peaks
- treble ringing
- lack of soundstage/imaging
- lack of clean bass
- lack of deep bass
- lack of system balance at lower SPLs
- crossover region colorations
- requirement for a low system noise level

The following paragraphs suggest some practical remedies for these limitations. We were impressed with the results of our experiments but we feel they only approach the limit of potential improvement. Some of these recommendations will not be appropriate or cost effective in commercial applications. Many of these recommendations apply to other Altec systems. Our goal was to optimize the A7 for full range, hi-fidelity use in relatively small, quiet, environmentally controlled spaces.

NOISE, NOISE, NOISE!

A7s are extremely efficient. The typical A7 has a pressure sensitivity of 105 dB SPL (1W/1M). You may discover your system noise floor is clearly audible through this speaker. Hum must be 1-2 mV or less for woofer inaudibility; even less if there is any non-sinusoidal component. The compression driver can reproduce thermal noise in its bandpass quite readily, and this may have to be reduced so as not to be intrusive in a quiet room (40-45 dBA). The following steps may be useful in achieving an acceptably low system noise level:

- use main amplifiers that have less than 1-2 mV of hum at their output with the input grounded
- eliminate system ground loops
- eliminate unneeded gain stages
- use stepped attenuators
- for unbalanced terminations, employ interconnects that use a shield as a drain
- upgrade stock speaker wiring, crossover wiring, and connectors
- upgrade stock internal wires between the compression driver binding posts and the diaphragm voice coil terminations
- clean all signal connection mating surfaces

These steps should result in greater usable dynamic range, lower harmonic distortion, an increase in low level program information, and better imaging. You promised to do this years ago, anyway, right?

WHICH WAY IS UP?

The speaker can either be configured "inverted", with the H.F. horn mounted in the cabinet reflex port and the short bass horn closest to the floor, (Magnificent, A7-W, some Utilities - Fig.2), or "upright", with the H.F. horn on top of the cabinet and the reflex port closest to the floor (Fig.1). If the

ALTEC A7 Systems

PERFORMANCE SPECIFICATIONS:		A7 SYSTEM	A7-500 SYSTEM
Power Rating:		30 watts	30 watts
Impedance:		16 ohms	16 ohms
Horizontal Distribution:		90 Degrees	90 Degrees
Vertical Distribution:		40 Degrees	40 Degrees
Frequency Response:		35-22,000 cps	35-22,000 cps
Pressure Sensitivity:		109.2 db (w/1 watt input at 4')*	109.2 db (w/1 watt input at 4')*
		124 db (w/30 watts input at 4')	124 db (w/30 watts input at 4')
Crossover:		800 cps**	500 cps***
Dimensions:	42" H 30" W 24" D (LF Horn Only)	52 ¼" H 30" W 24" D	54 ¼" H 30" W 24" D
Finish:		Theatre Gray	Theatre Gray
Weight:	100 lbs. (Cabinet)	135 lbs.	142 lbs.

* 109.2 db measured 4' from mouth of horn over warble frequency range 500-2,500 cps. (Ref: .0002 dynes/cm² for 1 watt input.)

** N-800D furnished; Adjustable in 4 steps of 1db *** N-500D furnished; Adjustable in four steps of 1.5 db

H.F. horn is removed from the port for upright mounting, the reflex port area must be reduced from approximately 375 to 220 square inches. The upright configuration is superior for bass projection and tightness, overall imaging, and a seamless blending of the drivers.

CAUTION: DIPS AHEAD

Each speaker requires crossover phase alignment of its two drivers for lowest distortion and best imaging. Altec recommends locating this point by: 1) positioning the driver voice coils in basic vertical alignment and then, 2) adjusting the H.F. driver/horn position (connected electrically out of phase from the woofer) to achieve the greatest observed dip at crossover on a real-time analyzer measuring speaker reproduced pink noise. A dip of 6-8 dB should be attainable. Reverse the H.F. connections when you finish securing the horn and the drivers will be in-phase at crossover.

ACOUSTIC MUD & OTHER FINDS

The stock bass cabinet contributes significant amounts of unwanted acoustic energy to program material. Reduce these vibrations by stiffening the box with external veneers or laminates and adding internal panel bracing of 2X2s or 2X4s glued and screwed on edge. Dampen the internal flare of the short horn with contractor's epoxy, tar, insulating foam, or other suitable material. Install braces between the short horn flares and the sides of the box. Brace the port boards with diagonal hardwood 1X2 glued and screwed on edge. These actions will eliminate the muddying distortions caused by cabinet radiations in the mid and upper bass.

Altec cast aluminum horns ring like the Liberty Bell. They need to have damping material applied to their exteriors until a knuckle rap produces only a "thunk". Use tar, Soundcoat, layers of latex paint over sand, lead, sand filled enclosures, or other suitable material. This will eliminate the treble ringing of the H.F. horn that is a major source of listener fatigue.

All air leaks in the box should be sealed. A common problem seen in many older boxes is a gap that appears along the bottom edge of the short bass horn flares.

SO MANY CHOICES, So Little Time

There are two basic families of compression drivers applicable to the A7 — the small 1" throat type and the larger 1.4" variety. The one inch family includes the 802, 804, 806, 807, 808, 902, 908, and 909. The one and a quarter inch type can be either a 288, 291, or a 299. There have been many cosmetic and performance changes over the years in both families.

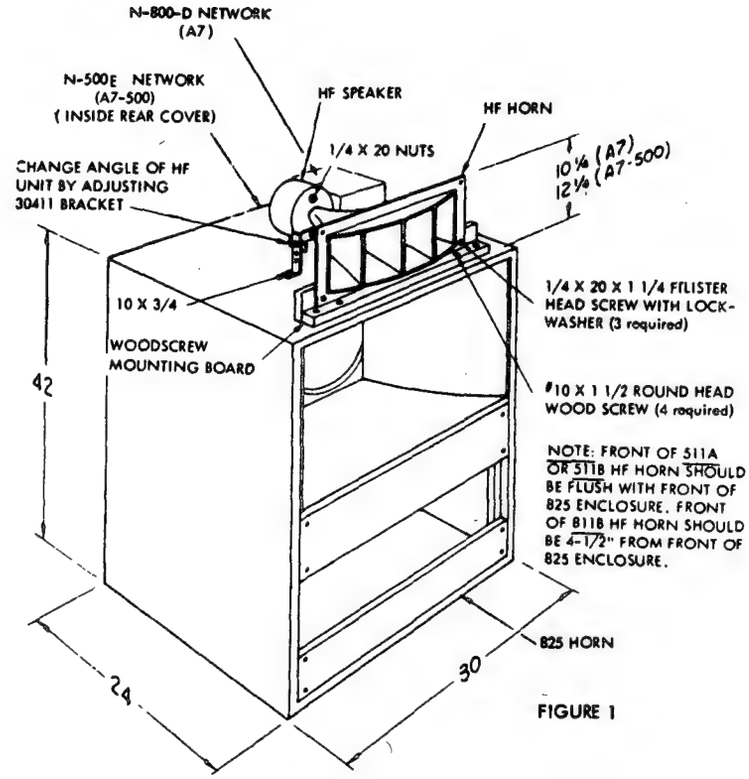


FIGURE 1

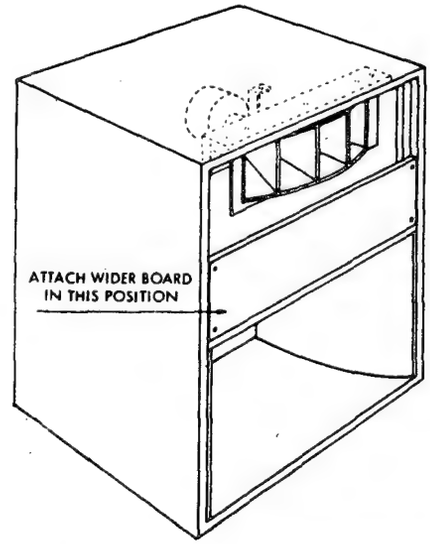


FIGURE 2

UPRIGHT AND INVERTED A7 CONFIGURATION

Generalities:

- Older units (pre 1980) use Alnico magnets ; later units use ferrite
- Older units (pre 1977-79) use a machined metal phasing plug; later units use the plastic "Tangerine" phasing plug
- Older units have a bronze throat screen attached to their mounting gasket; later units have a bronze or stainless screen sandwiched between the phasing plug and throat
- The 1 inch drivers bolt to the 511 or 811 sectoral horn directly; an adaptor is required to connect 1 inch drivers to larger sectoral, multicellular, or constant directivity horns designed for 1.4 inch drivers

ALTEC 311-60 AND 311-90 SECTORAL HORNS



The Altec 311-60 and 311-90 are the newest sectoral horns in the Altec line. They are designed for use in sound systems where a low cutoff and uniform control of the projection angle are required. These horns are treated with "Aquaplas", a patented sound deadening material, to assure freedom from resonance and ring. They are designed to operate with an Altec 288C, 290E or 730C Driver Loudspeaker through the proper receiver attachment. Use of an Altec N-500C Network or 15045A 70-volt matching transformer will provide driver protection. Both horns feature a 300-cycle cutoff frequency, and the sound pattern, controlled by the sectoral expansion, is 60-degrees horizontally for the 311-60, and 90-degrees for the 311-90. Vertical distribution for both horns is 40 degrees.

Many experimenters prefer longer, lower cutoff horns over the stock 511/811

- 1.4 inch drivers bolt directly to the large sectoral horns and to various throats of the multicells or CDs

Three types of diaphragms exist for Altec compression drivers:

1. Aluminum: low power handling; best transient and high frequency response (288, 802/902, 804/806)

2. Pascalite: high power handling; transient and high frequency response slightly less than aluminum. (299, 909)

3. Symbiotik: high power handling; poorest transient and high frequency response of the three. (291, 807, 808/908)

There are two basic families of woofers applicable to the A7 — the large magnet 515 series and the less efficient 803/416 variety. There have been many cosmetic and performance changes over the years in both families.

- Early units (515, 803A) use light, stiff cones with 40-45 Hz resonant frequencies and 16 to 20 ohm voice coil impedances
- Later units (515B and later, 803B/416A and later) use heavier cones with 25 Hz resonance and 8 or 16 ohm impedances
- Older units use Alnico magnets; later units use ferrite

DETAILS, DETAILS

Whether you choose small or large format compression drivers, eliminate the throat screens. These screens prevent bugs and other debris from entering the compression drivers in unattended or hostile commercial environments. Although light and thin, their construction has a polarizing effect on visible light. Remove them from the gaskets on older models; on later units cut an "x" across them with an Exacto knife, then grasp and remove them with a hemostat or large pair of tweezers. These "bug" screens are responsible for the bulk of midrange and treble distortions on program peaks, softening of treble leading edges, midrange colorations, H.F. signal attenuation, and phasey images that are hard to localize. Altec compression drivers sound excellent with these throat restrictions removed.

Whether you choose small or large format compression drivers, use aluminum diaphragms for best home sound. They are available in 8 or 16 ohms impedance for the 1" units; 8, 16, 24, or 32 ohms for the 1.4" types. Their only performance limitation is power handling, but this should be of little concern for Hi-Fi use unless you plan on producing constant, ear-shattering output levels. If you do, use the Pascalites.

Whether you use passive or active crossovers, stay at 500 Hz and employ a relatively long horn with a low cutoff frequency for best performance and sound. The 1" drivers will fit the larger sectorals, multicells, and CDs via throat adapters from Altec. A long horn with a low cutoff will provide more effective throat loading in the crossover region than the stock 511 horn. Consider 311s or 329As. The 329A resembles the 311 pictured above but with reinforcing bars instead of sectors.

Altec 500 Hz crossovers are excellent sounding units. Most are straightforward 12 dB/oct, parallel L/C, Butterworth types that were designed for 8 or 16 ohm loads. A few models (e.g. N500C and E) had their component values set for 12 ohms. Replace the stock wiring and capacitors in these units with your favorites to improve their sound. We measured the stock capacitors in several Altec crossovers and found that some had drifted in value considerably.

Still higher performance can be obtained by bi-amping the A7. I've listened through various solid state and tube crossovers employing 12, 18, and 24 dB/oct slopes and feel they all offer performance advantages over the single amp/crossover per speaker configuration. My favorite is the 24 dB/oct Linkwitz/Riley.

If you like to hear information above 10-12 kHz, opt for the 1" drivers over the 1.4" units. No contest here - tics on 802s sound like pops on 288s; leading edge attacks are razor sharp on 802s, softened on 288s. The 21216 adapter is a current Altec part which will allow the use of 1" drivers on horns designed for 1.4" drivers. Jobber price is around $75/pr.

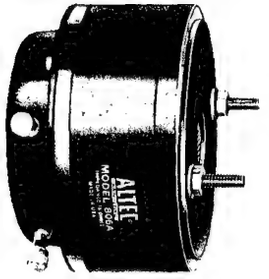
The midrange sounds cleaner on drivers that use the machined metal phasing plug. Distortion that is noticeable through a Tangerine plug on steady tones or program material is not present on the metal units.

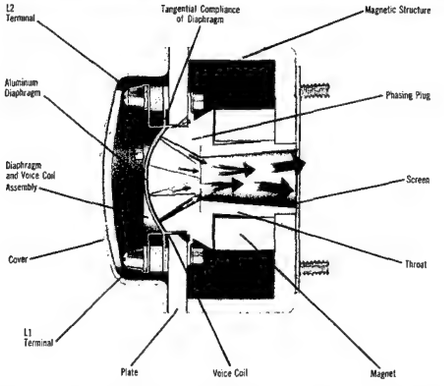
We prefer 416 type woofers in the A7 for the best overall performance in a Hi-Fi application. Use the 515 for low frequency augmentation.

(Continued on page 31)

802D & 806A Driver Loudspeakers

802D
806A





Features:

- 500-22,000 Cycle Response
- Smooth, Peak-Free Response
- Extremely High Efficiency
- Low Distortion
- Faithful Reproduction
- Aluminum Diaphragm with Tangential Compliance
- Edge-Wound Voice Coil
- 30-Watt Capacity
- Compact — Easily Installed
- Field Replaceable Diaphragm & Voice Coil Assembly

PROFESSIONAL 'PLAYBACK' SOUND SYSTEMS
BROADCAST & RECORDING STUDIOS • BALL ROOMS
AUDITORIUMS • SCHOOL & CHURCH MUSIC ROOMS
MUSIC HALLS • THEATRES • NIGHT CLUBS
DANCE STUDIOS • WIDE RANGE MUSIC SYSTEMS

The Altec 802D and 806A High Frequency Driver Loudspeakers are designed for all professional PLAYBACK applications requiring outstanding reproduction of sound over an extremely wide frequency range at substantial power levels. Such conditions are readily fulfilled with unusually high efficiency and exceptionally uniform response from 500/800 (dependent on the dividing network and horn employed) to over 22,000 cycles.

When used in conjunction with the Altec 511A, 511B (500 cycle) or 811B (800 cycle) sectoral horn,-the N-500D (500 cycle) or N-800D (800 cycle) network, and the 414, 515, or 803 low frequency loudspeaker, the 802D and 806A furnish the realistic reproduction demanded by all major broadcasting stations, recording studios, theatres, auditoriums and music halls.

Both the 802D and 806A transducers utilize a voice coil of notably large diameter (1¾") edge wound with aluminum ribbon and coupled to a large 2¼" aluminum diaphragm having tangential compliance. A mechanical phasing plug (i.e., pole piece), having two exponential acoustic slots, is utilized to provide the proper phase relationship between the sound emanating from the center and outer edges of the diaphragm and voice coil assembly, thus insuring maximum high frequency reproduction while maintaining a smooth overall response. Either driver is capable of uniform, peak-free reproduction to a point far above the range of human hearing. The entire diaphragm and voice coil assembly of the 802D and 806A is field replaceable; no special tools or skills are required.

For full range systems utilizing low frequency loudspeakers of relatively low efficiency, located in non-reverbrant areas having moderate ambient noise levels, the Altec 806A driver proves a perfect match.(Such conditions would be analgous to the average listening room or smaller broadcast and recording studio).

In instances wherein relatively high ambience is present, and where maximum efficiency of both vocal speech and music must be reproduced with greatest clarity, the heavier magnet weight and greater flux density of the 802D are preferred. The 802D represents one of the finest high frequency transducers manufactured by Altec; the 2 db greater efficiency (over the 806A), coupled with the same precision accuracy of minute production tolerances, make the 802D the industry standard for laboratory and professional usage alike.

These factors, together with the all-important Altec criterion of engineering experience, combine to produce the 802D and 806A high frequency loudspeakers of virtually matchless quality and limitless application.

ALTEC LANSING

RECORDING & BROADCASTING EQUIPMENT

From 1966 Altec Specifications for Engineers and Architects

ALTEC 802D 806A

SPECIFICATIONS

	802D	806A
Power:	30 watts (with N-500D or N-800D Network)	30 watts (with N-500D or N-800D Network)
Frequency Response:	500-22,000 cycles	500-22,000 cycles
Pressure Sensitivity:	111.7db* at 1 watt; 126.4db at 30 watts	109.5db* at 1 watt; 124.2db at 30 watts
Impedance:	16 ohms	16 ohms
Voice Coil Diameter:	1.75"	1.75"
Application:	HF Driver unit for wide-range, two-way studio 'Playback' Systems	HF Driver for wide-range, two-way, studio 'Playback' Systems
Protection:	N-500D Network and 511A or 511B horn for 500 cycle crossover	N-500D Network and 511A or 511B horn for 500 cycle crossover
	N-800D Network and 811B horn for 800 cycle crossover	N-800D Network and 811B horn for 800 cycle crossover
Magnet Weight:	1.2 lbs.	13 oz.
Flux:	15,250 Gauss	13,000 Gauss
Dimensions:	Diameter: 4½" Depth: 3 1/16"	Diameter: 4½" Depth: 3¼"
Weight:	7 lbs.	5 lbs., 11 oz.
Finish:	Altec Green	Altec Green
Accessories:	511A, 511B, 811B Sectoral Horns; N-500D, N-800D Dividing Networks; 70.7v transformers	511A, 511B, 811B Sectoral Horns; N-500D, N-800D Dividing Networks; 70.7v transformers

*(Ref: .0002 dynes/cm² measured with warble frequency 500 - 2,500 cycles, 4' from mouth of 30" trumpet)

Note: For Multicellular Horns use Altec drivers 730, 288 and 290 types.

ARCHITECTS' & ENGINEERS' SPECIFICATIONS

(FOR ALTEC 802D):

The high frequency driver loudspeaker shall utilize a 2¼" diameter aluminum diaphragm having tangential compliance, coupled to a voice coil of edge wound aluminum ribbon having a diameter of 1¾". The voice coil gap shall have a flux density of at least 15,250 Gauss, produced by a magnet having a weight of 1.2 pounds. A machined phasing plug, which also serves as the pole piece, having two exponential acoustic slots shall be utilized to provide the proper phase relationship between the sound emanating from the center and edges of the diaphragm and voice coil assembly, thus insuring maximum high frequency reproduction while maintaining a smooth overall response. The entire diaphragm and voice coil assembly shall be field replaceable without requiring special tools or skills; this shall be interpreted to mean that the speaker shall incorporate self-centering dowels to insure proper spacing and alignment of the diaphragm and voice coil assembly.

The HF driver loudspeaker shall produce a sound pressure level of at least 111.7 db with 1 watt input and 126.4 db with 30 watts input at a distance of 4 feet from the mouth of a 30" trumpet when a warble band of 500 to 2,500 cycles is used. Single frequency measurements shall not be acceptable under this specification. The frequency response of the HF driver shall be uniform over the range of (SPECIFY):

500 to 22,000 cycles, when used with the Altec 511A or 511B sectoral horn and N-500D dividing network.
800 to 22,000 cycles, when used with the Altec 811B sectoral horn and N-800D dividing network.

Any high frequency driver loudspeaker not meeting all of the foregoing requirements shall not be acceptable under this specification.

The high frequency driver loudspeaker shall be Altec Lansing Model 802D.

(FOR ALTEC 806A):

The high frequency driver loudspeaker shall utilize a 2¼" diameter aluminum diaphragm having tangential compliance, coupled to a voice coil of edge wound aluminum ribbon having a diameter of 1¾". The voice coil gap shall have a flux density of at least 13,000 Gauss, produced by a magnet having a weight of 13 ounces. A machined phasing plug, which also serves as the pole piece, having two exponential acoustic slots, shall be utilized to provide the proper phase relationship between the sound emanating from the center and edges of the diaphragm and voice coil assembly, thus insuring maximum high frequency reproduction while maintaining a smooth overall response. The entire diaphragm and voice coil assembly shall be field replaceable without requiring special tools or skills; this shall be interpreted to mean that the speaker shall incorporate self-centering dowels to insure proper spacing and alignment of the diaphragm and voice coil assembly.

The HF driver loudspeaker shall produce a sound pressure level of at least 109.5 db with 1 watt input and 124.2 db with 30 watts input at a distance of 4 feet from the mouth of a 30" trumpet when a warble band of 500 to 2,500 cycles is used. Single frequency measurements shall not be acceptable under this specification. The frequency response of the HF driver shall be uniform over the range of (SPECIFY):

500 to 22,000 cycles with the Altec 511A, 511B sectoral horn and N-500D dividing network.
800 to 22,000 cycles with the Altec 811B sectoral horn and N-800D dividing network.

Any high frequency driver loudspeaker not meeting all of the foregoing requirements shall not be acceptable under this specification.

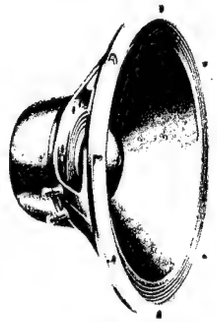
The high frequency driver loudspeaker shall be Altec Lansing Model 806A.

414A, 416A, 515B L. F. Loudspeakers

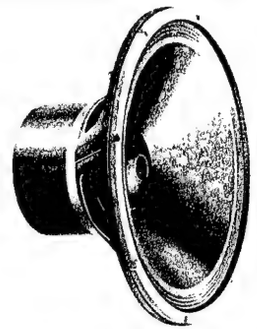
414A
416A
515B



414A



416A



515B

Features

- Heavy Alnico V magnet
- Edge-wound voice coil
- Rugged construction
- Smooth response
- High efficiency
- Low cone resonance
- Low distortion
- High power capacity
- High linearity

LOW FREQUENCY SPEAKERS FOR WIDE-RANGE, TWO-WAY SOUND REINFORCEMENT SYSTEMS • OUTSTANDING AUDIO REPRODUCTION FOR THE LARGEST CONCERT HALL, THEATRE, AND AUDITORIUM SYSTEMS • PROFESSIONAL 'PLAYBACK' SYSTEMS • BROADCAST AND RECORDING STUDIO MONITORING

Altec low frequency loudspeakers are designed for use in the finest recording and broadcast studio 'Playback' systems as well as providing outstanding reproduction of the lower audio spectrum when used in two-way systems for the largest theatres and auditoriums. Utilizing heavy Alnico V permanent magnets, rugged, die-cast frames, edge-wound copper ribbon voice coils of the largest practical diameter, and exceptionally compliant cone suspension, these LF transducers combine the advantages of long-term operation with unparalleled response throughout the entire audible bass frequency range.

The smooth response and exceptional linearity of each loudspeaker is achieved by means of strict adherence to precision design and manufacturing tolerances. The axial retention of the voice coil, in a magnetic field uniform over the full excursion, assures the clarity of bass reproduction at high power levels. The low cone resonance, when coupled to a properly designed Altec enclosure, eliminates virtually all 'doubling' or self-generation of unwanted harmonic components.

The Altec 414A, with a range exceeding 30 to 4,000 cycles, is an outstanding 12-inch LF transducer — ideal for use in institutional and entertainment systems of moderate size and coverage area. The power rating of 25 watts makes the 414A, singly or in multiples, an excellent choice in two-way systems utilizing Altec high frequency drivers and sectoral horns.

The Altec 416A is a 15-inch low frequency loudspeaker of professional quality, chosen to complement the finest broadcast and recording studio monitor systems (such as the Altec A7 and A7-500) in addition to providing the critical listener with superb bass reproduction for all wide-range public address, sound reinforcement and theatre or auditorium systems.

The Altec 515B, with its exceptional low frequency response, high efficiency and ability to faithfully reproduce the lowest audio frequencies at unusually high power levels remains the unchallenged leader in the largest and finest two-way systems throughout the world. When used in conjunction with the Altec 288C HF driver, N-500C dividing network and multicellular horn of the desired size and coverage angle, the 515B becomes an integral part of the identical Altec 'Voice of the Theatre' loudspeaker systems currently employed by the majority of the largest and finest theatres, auditoriums and concert areas.

ALTEC LANSING

ALTEC 414A, 416A, 515B

SPECIFICATIONS

	414A	416A	515B
Power Rating (Continuous):	25 watts	30 watts	35 watts (50 watts peak)
Frequency Response:	30-4,000 cycles	20-1,600 cycles	20-1,000 cycles
Pressure Sensitivity:	99 db (SPL at 4' from 1 watt*) 113 db (SPL at 4' from full 25 watts)	99 db (SPL at 4' from 1 watt*) 114 db (SPL at 4' from full 30 watts)	103 db (SPL at 4' from 1 watt*) 118.5 db (SPL at 4' from full 35 watts)
Impedance:	16 ohms	16 ohms	16 ohms
Cone Resonance:	30 cycles	25 cycles	25 cycles
Voice Coil Diameter:	3"	3"	3"
Magnetic Assembly:			
Magnet Weight:	1.8 lbs.	2.4 lbs.	4.4 lbs.
Magnet Type:	Alnico V	Alnico V	Alnico V
Flux Density:	10,000 Gauss	12,000 Gauss	14,750 Gauss
Construction:			
Frame (Basket):	Structurally-reinforced cast aluminum	Structurally-reinforced cast aluminum	Structurally-reinforced cast aluminum
Cone:	Molded Fibre	Molded Fibre	Molded Fibre
Cone Suspension:	High-compliance cloth surround with mechanical resistance	High-compliance cloth surround with mechanical resistance	High-compliance cloth surround with mechanical resistance
Voice Coil:	Edge-wound copper ribbon	Edge-wound copper ribbon	Edge-wound copper ribbon
Diameter:	12¼"	15⅜"	15⅜"
Weight:	15 lbs.	17½ lbs.	26 lbs.
Mounting:			
Mounting Hole Diameter:	10¼"	13¼"	13¼"
Mounting Bolt Centers:	4 holes, equally spaced, on 11⅜" centers	4 holes, equally spaced, on 14⅜" centers	4 holes, equally spaced, on 14⅜" centers
Loudspeaker Depth:	5⅝"	7"	7¾"

The Altec 414A, 416A, and 515B low frequency speakers may be used to greatest advantage in wide range, two-way systems with the addition of the following Altec components:

HF Drivers & Horns: 802D & 806A (with 511A/B or 811B Sectoral Horns)
288C & 290D (with Altec multicellular horn having proper cutoff frequency and distribution pattern)

Accessories:
Altec Loudspeaker Enclosures: For 414A: 612B, 614B, 618B, 622B, 855A, 858A, 859A.
For 416A & 515B: 612B, 614B, 825A, 855A, 856A, 857A, 858A, 859A, 210, 410.

Dividing Networks: N-800D (800 cycle crossover)
N-500C (500 cycle crossover)
N-500D (500 cycle crossover; for use with Altec 802D & 806A HF Drivers)

*414A = EIA rating of 52db at 30 ft. from 1 milliwatt
416A = EIA rating of 52db at 30 ft. from 1 milliwatt
515B = EIA rating of 56db at 30 ft. from 1 milliwatt

ARCHITECTS AND ENGINEERS SPECIFICATIONS

414A

The low-frequency speaker shall be 12" in diameter and shall have a minimum pressure sensitivity of 99 db (spl at 4 ft. from 1 watt) measured on axis. The voice coil shall be approximately 3" in diameter and shall be of edge-wound copper ribbon operating in a magnetic field of at least 10,000 gauss derived from an Alnico V magnet weighing 1.8 pounds minimum. Speakers with smaller voice coils or round wire windings are not acceptable under this specification. The free-air resonance of the speaker shall not be greater than 30 cycles and it shall have a continuous power rating of at least 25 watts. Frequency response of the speaker shall range from 30 to 4,000 cycles. Any low-frequency speaker not meeting all of these requirements shall be deemed unacceptable under this specification.

The speaker shall be Altec Lansing Model 414A.

416A

The low-frequency speaker shall be 15" in diameter and shall have a minimum pressure sensitivity of 99 db (spl at 4 ft. from 1 watt) measured on axis. The voice coil shall be approximately 3" in diameter and shall be of edge-wound copper ribbon operating in a magnetic field of at least 12,000 gauss derived from an Alnico V magnet weighing 2.4 pounds minimum. Speakers with smaller voice coils or round wire windings are not acceptable under this specification. The free-air resonance of the speaker shall not be greater than 25 cycles. The speaker shall have a continuous power rating of at least 30 watts and shall have a frequency response from 20 to 1,600 cycles. Any low frequency speaker not meeting all of these requirements shall be deemed unacceptable under this specification.

The speaker shall be Altec Lansing Model 416A.

515B

The low-frequency speaker shall be 15" in diameter and shall have a minimum pressure sensitivity of 103 db (spl at 4 ft. from 1 watt) measured on axis. The voice coil shall be at least 3" in diameter, of edge-wound copper ribbon, operating in a magnetic field of at least 14,750 gauss derived from an Alnico V magnet weighing 4.4 pounds minimum. Speakers with smaller voice coils or round wire windings are not acceptable under this specification. The free-air resonance of the speaker shall not exceed 25 cycles. The speaker shall have a continuous power rating of at least 35 watts and a peak power rating of at least 50 watts. Frequency response shall be uniform from 20 to 1000 cycles. Any low-frequency speaker not meeting all of these requirements shall be deemed unacceptable under this specification.

The speaker shall be Altec Lansing Model 515B.

WHO STOLE THE DEEP BASS?

Nobody. The stock A7 cabinet cannot efficiently produce deep bass due to the relatively high box resonance created by its low port area to internal volume ratio. If you increase the ratio (hopefully by decreasing the port area - not enlarging the box!) the rise in electrical impedance will degrade the bass smoothness, efficiency, and transient response that the A7 is famous for. The solution to this dilemma is to find a subwoofer that can be blended seamlessly with the A7 "sound". We couldn't find any.

We became interested in adapting the Karlson Enclosure to this task after Bill Fisher related an anecdote about the ability of this mid-50s design to produce significant low frequency output from a relatively small volume. The story went something like this: A mysterious source of energy was shaking things off the wall in the juke box repair shop. It was eventually traced to infrasonic turntable rumble being reproduced by the shop's Karlson test speaker!

The Karlson is a folded pipe configuration that drives its bass output through a tapered, exponential slot with both front cone radiation and a chamber driven reflex port. A pair of K-15s were soon acquired for experimentation. While John applied his professional level of carpentry skills to the modifying and refinishing tasks, I busied myself with tuning, impedance and response testing, and bandpass filter design.

Specific modifications applied to the Karlson Enclosure for 15" drivers included:

- Altec 416 or 515 woofer with 25 Hz resonant cone installed
- Stock reflex port replaced with two 3", 90 (degree) PVC elbows.
- Enclosure tuned to 30 Hz
- Active bandpass filter implemented; centered at 30 Hz with -3 dB points at 19 and 45 Hz; 12 dB/oct skirts. (Requires 12 to 15 dB of boost above line level at 30 Hz for good subjective blending with A7s)
- Carpet piercing spikes attached to cabinet

The Karlson adaptation adds seamless balance to A7 based systems when reproducing music and movie soundtracks containing deep bass. The Karlson, like the A7, is easy to drive — a Mac 40 works well.

FINAL MIX

The performance that results from carefully optimizing the small Altec VOT speaker for Hi-Fi can be truly stunning. The remedies that we have suggested here can be applied to the thousands produced since 1947, including the current production A7-8G system. If you don't think a speaker can have explosive dynamics, wall-to-wall imaging, a seamless midrange that just won't quit, incredibly low distortion, a sweet, airy, top end, and do all this *without a hint of strain*, you haven't driven a good horn system lately!

Footnotes:

[1] Ted Uzzle, "Polarity and Phase", Application Note AN-9, Altec Lansing Corp., 1986.

RESOURCES

Factory reconing service is available for most Altec woofers. Your local reconing service might be competent to replace cones but Altec has equipment to remagnetize drivers, a procedure often required after 15 or 20 years of service to restore full performance. Contact Altec Service Dept. for more information.

Altec Lansing Corporation
P.O. Box 26105
Oklahoma City, OK 73126-0105
405-324-5311

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About the Authors

Jeff Markwart and John Tucker work for Aerospace firms supplying Space Shuttle and Space Station engineering services to NASA at the Johnson Space Center in Houston, Texas. Their terrestial pursuits include design, construction, and modification of sound equipment for use in musical sound reinforcement and hi-fidelity audio.



Photo from 1956 advertisement

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AUDIO

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The Core Issues:

To POT. . . or NOT?
The myth of potted transformers

by Mike LaFevre, MagneQuest

"The Core Issues" will examine the function, construction, design and operation of magnetics for audio applications. This series will combine practical advice in the form of useful "rules of thumb" with enough pure theory to give us some concept of how these magnificent devices work. This column is not an academic engineering tutorial, but rather a guide to becoming an informed consumer.

This installment of the Core Issues will explore the benefits and disadvantages of "potting." Given a choice, 99 out of 100 audiophiles will, any day of the week, pick a potted transformer over one that is not potted. What lies at the heart of this strong preference among audiophiles? Is it simply a case of judging a book by its cover?

Am I just being hopeful or is it true that end users are sophisticated enough to realize that you can't make a silk purse from a sow's ear and that there will be some "pretenders." Plainly speaking, transformers that are poor performers create a strong illusion of being a quality transformer when potted in beautiful cans.

In this article I plan on digging beneath surface appearances. I will challenge the notion that potted transformers are inherently better than nonpotted transformers. In fact, I plan to boldly argue for the opposite, which is to say that I will present a host of arguments in favor of not potting transformers for sound performance reasons in the majority of consumer applications.

MARKETING

"Hi-fi packaging." Have we come full circle? I can remember in the mid-1970s reading in the underground rags (they were then much truer to the spirit and real concerns of the burgeoning audiophile community) that the entrenched giants, and especially the Japanese mega-corporations, were "ripping off" the audiophile.

The argument was that there was a lot of sizzle and very little steak in product offerings. Most of the money spent in manufacturing the product went into faceplate, the idiot lights, and the overall physical packaging. The strategy: Make it physically sexy and alluring and they will buy. The underground argued that manufacturers should be more concerned with what's in the box and what comes out of the box rather than the size and overall appearance of the box. Good common sense. But have we come full circle?

As many readers are aware, contemporary hi-fi packaging makes the antics of the 1970s players look rather modest and restrained. In today's "high end" market, a disproportionate share of resources is dedicated to "packaging" of many contemporary products. I lost count some time ago of the number of "high-end" manufacturers who told me openly or in confidence that they spend more money on the box that they put their transformers on (or even the can they put the iron in!) than they do on the transformers themselves.

We get stainless steel cans, lacquered cans large enough to hide a small Hyundai in, and cavernous deep-drawn tombs which have been designed to house large volumes of air and/or potting compound in addition to the transformer. All for the sake of impressing you, the consumer.

ECONOMICS

Since I brought up the issue of cost, let's explore this a little further. Although it may seem counterintuitive to most readers, sometimes transformers are potted because it is actually cheaper overall, than the other options available to the designer or manufacturer.

On some cost-constrained products, it is cheaper to use a less expensive grade of laminations, a smaller core section, and/or less ambitious copper package, knowing full well that, for instance, your heat rise will be excessive and your regulation poor but that you can bail it out by potting the unit.

There are many different types of potting compounds and formulations available. Some formulations are specifically designed to dissipate heat. The trick here is that, when potted, the "too small" transformer has a much larger cooling surface area. The effective cooling area can be greatly expanded by putting the unit into a larger can and selecting a compound that is effective in pulling the heat way from the core — the best analogy is that of a heat sink. This "Band-Aid" approach has utility in situations where space is at a premium, such as in aerospace work, but definitely doesn't belong in audio.

There are other applications for which potting saves labor and expense. If your end user demands a high degree of "fit and finish", sometimes it is less expensive to forego the steps necessary for it to look good in bell end caps and simply put the unit in a can. Unfortunately, some units are potted because the last thing the manufacturer wants you to see is the quality of workmanship and/or the materials that went into your unit. If housed in bell-end caps, it is much easier to directly view and evaluate the quality of care and evidence of workmanship expended on the unit. It's much harder to hide your work when the transformer is displayed in bell-end caps.

GOOD REASONS TO POT

I trust that it is obvious that not every company that has ever potted a transformer did it for pure marketing reasons and/or for marketing impact. Let's take a look at some engineering derived arguments in favor of potting transformers.

There are some lamination shapes and sizes for which there exist no commercially available bell-end caps and/or L-shaped brackets with which the transformer can be both held immobile while simultaneously providing a means with which it can be attached to a chassis. C-core laminations, for

instance, do not have any bolt holes drilled through the laminations. You simply cannot put a traditional bell-end or L-bracket on this type of lamination. While other mounting hardware has been developed that would allow a C-core based product to be mounted without potting it, it is generally preferred to either pot it in a can or bury it in a chassis where the end user cannot go exploring with his/her fingertips, since many of these coils carry lethal voltages.

Safety is almost always a good reason for doing something. But practical reasons prevail in cases where no other good alternatives exist. Such was the case for the famous Acrosound transformers. Their outputs were built on a punched lamination with appropriate mounting holes. But their unusual size and shape meant no one offered bell ends for that lamination type. The most practical choice was to pot the transformer.

Another valid reason for potting is challenging environmental conditions. This particularly applies to mil-spec transformers. A transformer built for Uncle Sam's militia must withstand many perils, including salt spray, fungus growth, extreme temperature cycling, vibration, shock, drop tests, etc. (For a more complete treatment of the special requirements imposed on transformers going into the military, please review The Core Issues in *Sound Practices* #1).

Unless you plan to expose your precious trannys to environmental evils, you are unlikely to require the protection offered through Mil-spec packaging—or at least not for these reasons.

Uncle Sam was a big enough buyer that many companies competed for this business as either a prime contractor or a qualified subcontractor. Triad, for example, had a line of audio transformers called the HSM series which met the stringent requirements of Mil T-27 (which addresses almost exclusively packaging issues). Its "S" series employed the same coil and core as its HSM series counterparts minus the mil-spec packaging. Both the S-146A and the HSM-186 enjoy the same specs on paper. The S-146A costs less because it was in bell-end caps.

Another often cited advantage of potting transformers is that a potted trans seals out moisture and dampness. In the past, say 30 to 40 years ago, this may have been a strong argument. At that time, many of the insulating materials for inside the transformer were organic materials like cotton and kraft paper; even the magnetic wire coatings were much more adversely affected by moisture and humidity since they too were largely based on organic chemicals.

Many of the premium materials used in transformers today are inherently non-hygroscopic. This is a fancy way of saying that they will not absorb moisture. Teflon, for instance, is pretty much impervious to moisture. You can dunk it in a bucket of water and for all intents and purposes, it does not absorb water. Most of the materials favored by today's constructors such as polypropylene, polyethylene, nomex, kapton, ultem, mylar, etc., are non-hygroscopic. Voltage breakdown due to arcing or tracking caused by the presence of moisture is rarely a problem in modern transformers.

In fact, many of the different types of transformers made today, including many of the toroids and bobbin-wound units, are not impregnated at all nor are they potted. Yet they still survive and function day in and day out.

NOISE

Another reason cited in favor of potting is that a potted transformer will be less noisy by eliminating mechanical vibrations which can originate within the core itself or in the lamination stack. The potting proponents are mostly right. If the proper potting materials and methods are used, it is possible to quiet down a noisy transformer. But here again this is treating the symptom and not the cause. True, it is important to minimize mechanical noise in a trans but I prefer to address this potential problem right from the beginning.

Mass-produced transformers are frequently wound on formers which are larger than the nominal core dimensions. This is done to make it possible to machine stack the core with an automatic laminator (which reduces production costs) and to minimize the possibility of the laminator jamming as the stacking nears completion. The little bit of "slop" built into the stack height is then filled by wedging the coil and the core with a maple or phenolic wedge shaped spacer. This is intended to tighten the interface between the coil and the core and keep this interface quiet and chatter-free.

If you carefully construct your coils and do a good job in laminating the stack, you can build a trans that is eerily quiet without the aid of potting. This requires that the coil be wound with proper tension on the magnet wire, that even winding lengths be maintained, and that the coil be laminated with care and patience to completely fill the stack. Proper hand winding almost always results in a higher "K" factor than machine stacked coils. Squaring of the laminations also decreases the incidence of stack-induced hum. Choosing a high-grade lamination with low losses also decreases the magnitude of stack noise. Even the insulating material's physical properties will, if suitably chosen, aid in preventing noise that is generated within the coil by the passage of current through the conductor. There is not a lot of magic here—just old fashioned trial and error, attention to detail, and the desire to do it right.

PERFORMANCE CONSIDERATIONS

So far, I've demonstrated that potting is not necessary in most applications given intelligent design choices and careful building techniques. Now the astute reader might ask, "What harm is done by potting?" This question brings us to the crux of the debate. For if potting a transformer has no drawbacks and doesn't impose any penalties on the performance of the transformer, then why not pot?

There are costs associated with potting. First and most obvious is that in most designs the potting will add to the sale price of the unit. But as dedicated audiophiles, who cares?! So, let's not even count this as a potential disadvantage of potting. We are all after pure performance, right?

And it is purely in the performance realm that I wish to challenge the notion that a potted transformer is somehow inherently better than a non-potted unit. In fact, the reverse is true—potting *always* imposes some penalties on the performance of transformers. Most of my comments directly apply to audio output transformers or other types that must pass wide bandwidth audio signals. However, many of the same arguments also apply to power supply transformers.

First and foremost, every time you pot a transformer in a can, you increase its capacitance. I am fond of pointing out to customers that potted transformers have all the essential ingredients of a capacitor.

Look at it this way: a capacitor is a simple device which has at least two conductors (or plates), a dielectric (insulation), and an AC voltage potential (or differential) between the two plates. So, let's look at our potted trans. The coil, or parts of it, have an AC voltage potential above ground (the signal voltages from your output stage), while the case or pot is at AC ground potential.

In the void between the pot and the coil is a potting compound which is nothing more than an electrical insulator. Like all insulators, it has the ability to store an electrostatic charge. This charge (capacitance) is like all other capacitances; it tends to exhibit (to a greater or lesser extent, depending on the insulator) markedly nonlinear behavior. Its dielectric constant, which is a measure of how much potential capacity it can store, changes with both temperature and frequency. The dissipation factor, a measure of a capacitor's ability to dissipate a stored charge, of an insulator also is nonlinear with temperature and frequency changes.

Of course much research has been done on the effects of capacitors, and I need not rehearse the litany of gremlins associated with the electrical functioning of capacitors. We all know the woes of capacitors—when we use them we try to select the best—but when there is no real need for them, wouldn't pure performance considerations dictate that we not use them?

To make matters even worse, coils are made up of a multitude of winding layers, each having on either end a voltage different than that above it or below it, so that when you pot the coil there may be several dozen points at which there is a discrete voltage potential between the coil and the potting assembly. You can actually measure the increase in capacitance of the transformer before potting and after potting. Also note the increase in the exciting current, the decrease in permeability (in many cases) and the decrease in the resonant frequency of the transformer. It's not a pretty picture.

The resonant frequency of a transformer is that spot where the inductive reactance equals the capacitive reactance. Adding capacity to a coil will always result in this junction occurring at lower and lower frequencies in proportion to the additional capacitance added. The first or lowest resonant frequency of an output transformer is a measure of its useful frequency extension.

Above the resonant frequency many transformers will show a sharp falloff in frequency response and will exhibit markedly more ragged phase response. All things being equal, you want that resonant frequency to be as high as is consistent with good overall design practices. This is especially important in push-pull transformers which utilize global feedback. Potted transformers always pay a price in the diminution of extended high frequency response and the "quality" of their response range.

Surprise, surprise. On the bottom end of the frequency range, potted trannys often also pay an additional sonic penalty. An important performance consideration in the design of transformers is to keep the exciting current as low as is practical. While I'll be covering exciting currents in more depth in a later installment, suffice it to say that the exciting current component can be thought of as the energy necessary to set up a magnetic field in the iron core of the transformer.

The grade of lamination, its thickness, and the quality with which it is stacked all have an impact on the amount of exciting current consumed by the transformer. For now, think of increased exciting current as being "wasteful". The ability of a transformer to deliver clean, undistorted power into low frequencies is inversely proportional to its exciting current.

In addition to the lamination material used, how the laminations are handled and housed affects the magnitude of exciting current and, hence, its bottom end performance. Many methods and materials used in potting transformers can have an adverse effects on this parameter. If potting compound "creeps" in between the laminations you will get reduced stacking factor (K factor), the measure of how void-free the stack is. If it is not 100% filled by laminations, then the stack will work harder because of increased magnetic reluctance (i.e., the magnetic correlate of resistance).

If you do anything to the laminations that reduces their permeability, you also increase the exciting current of the unit—for example, if you hammer or otherwise exert a lot of force to "square" the lams. Many of the materials used to pot transformers have such great compressive strength when they cure (and shrink in the process) that they exert great pressure on the coil and laminations, thereby distorting the coil and decreasing the permeability of the iron. This is especially true with nickel-based lams. The worst offenders are modern epoxies and polyurethanes. Incidentally, these materials also have high dielectric constants and very poor dissipation factors—other good reasons to avoid them.

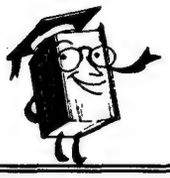
Impregnating a coil with an insulator like wax or varnish also increases exciting current. I learned of this phenomenon while studying drawings in the Peerless archives. They tested the magnitude of exciting current before impregnation, after impregnation, and after potting. The exciting current always increased after each step. The before and after figures typically varied by 20 to 25%! Magnetic materials are so sensitive that even the type of hardware used to keep the laminations together will have a measurable impact on exciting current. Nonmagnetic materials are best, obviously.

The moral of the story is the less you handle the cores, the better. Less processing, better and more careful workmanship in construction, and less dependence on after the fact "cures" results in better overall performance of the transformer.

Let me issue a few quick disclaimers before the arrows start to fly. The editor has promised me a safe haven. [*ed.- No way! You're on your own, dude.*] Low-level input transformers made with very high permeability nickels usually require potting for satisfactory performance. Here the "cans" are usually multiple units, one tucked into the other, made from mu-metal and interspersed with copper shields. This is necessary to shield the very sensitive nickel from stray magnetic fields. Even the smallest magnetic field can have detrimental effects in some low-level applications. Such small fields would have zero effect on silicon based laminations whose initial permeability is high. A steel pot or steel bell-end cap will provide about 10 dB of magnetic shielding if you are nervous about this. Aluminum, however, is useless for shielding.

There may be other specific applications in which potting is necessary or beneficial. What I have tried to demonstrate in this article is that there are always costs imposed on performance in ALL potted transformers. In the case of high-level audio output transformers, the costs far outweigh any of the alleged benefits of potting.

Till next time. . . happy listening!



from the archives

ELECTRONIC PHONO FACTS

by Maximilian Weil

An audio pioneer, founder of Audax company, provides a timeless statement on what Hi-fi is all about. Reprinted from an Audax brochure of the mid 1950s.

OF THE HUNDREDS of letters received by the writer from day to day, it is astonishing to find that a large percentage is from readers who are in no way connected with the field of electronics. In some way, they have gained a working knowledge of audio equipment and are more critical in selection of apparatus.

Of the many questions in the field of sound reproduction that such letters contain, the most frequent ones are answered here.

It was back in 1935 that "high fidelity" became the talk of the industry. At that time, the Radio Mfrs. Assn. issued a definition of high fidelity as — "equipment capable of reproducing frequencies to 7,500 cps or over." This was most unfortunate, as it made *wide range* and *high fidelity* synonymous. Since then, audio equipment has been built to kilocycles and more kilocycles.

On the one hand, the purchaser buys a high-fidelity audio system in the belief that the performance will be, as claimed, one of *fidelity*. That, to the purchaser, means *listening quality*. To the technician, on the other hand, it means wide frequency range in most cases.

According to the above definition, the technician is not misrepresenting, if the audio system *is* capable of reproducing a wide frequency range. At the same time, however, the purchaser is in the firm belief that he is buying *listening quality* performance. Accordingly, the deal is a sort of legal fraud, with both parties innocent of it.

Let us cite a few actual cases:

Mr. Smith, who had just bought a high-fidelity audio system on sales talk such as "crisp," "sharp as a razor," "you can hear the resin on the bow," etc., is much disappointed and disillusioned.

Says Mr. Smith, "It sounds very unpleasant. I decided to check up and went to a concert. At the actual concert, the music I heard was not 'crisp,' not 'sharp as a razor,' I didn't hear the resin on the bow and, what's more, I didn't want to." Smith then puts the treble-control to work, cutting off a lot of kilocycles for which he paid that extra money.

Take the case of Mr. Newman, who just paid over $650.00 for a high-fidelity system. He is disappointed and complains. The seller answers, "This is 'high-fidelity,' you have to become used to it..." Mr. Newman says, "That's nonsense, no one has to get used to it when at an actual concert and that is the real thing, Mr. High Fidelity himself."

The term high fidelity, as used in connection with audio apparatus, has always seemed to me unfortunate. Why *high* fidelity? Sounds very much like the man who keeps emphasizing that he is *highly* honest — as though there were different degrees of honesty.

Here is a quick test: Compare two pick-ups A and B of different makes but whose wide-frequency characteristics are substantially the same. One will be found to perform with *fidelity*, with pleasing musical quality while the other will be harsh, strident, shrill. Yet, both have the same range. *Mere extension of frequency range does not, by itself, result in listening quality.*

The interchangeable use of *high fidelity* and *wide frequency range* is probably rooted too deeply by now. However, for the good of the audio industry, *high fidelity* should be redefined in order to stop continued misunderstanding.

(*From the archives of David Sarzer*)

AUDIO NOTE UK OUTPUT TRANSFORMERS

15 W for EL84/ECL86/6V6 PP	9K-4/8 ohm	$70
25 W for 2A3/300B PP	5K-4/8 ohm	$110
25 W for EL34/KT66/6L6 PP	6K-4/8 ohm	$100
50 W for KT88/6550A PP	6K-4/8 ohm	$130
50 W for EL34/KT66/6L6 PPP	3K-4/8 ohm	$130
50 W for 845 PP	6.8K-4/8 ohm	$215
60 W for 6550/KT88/EL34 PP-UL !!!	4.3K 4/8/16 ohm	$120
15 W for EL84/6V6 PSE 110ma	2.6K-4/8 ohm	$125
25 W for 6L6/KT66 PSE 140ma	2.1K-4/8 ohm	$150
25 W for 2A3/300B SE 90ma	2.5K-4/8 ohm	$165
25 W for 2A3 PSE 130ma	1.25K-4/8 ohm	$145
25 W for EL34/6550A PSE 180ma	1.5K-4/8	$135
25 W for 211/845 SE 150ma	10K-4/8 ohm	$210
50 W for 211/845 SE 150ma	10K-4/8 ohm	$225
50 W for 2A3/300B PSE 180ma	1.25K-4/8 ohm	$235
50 W for 845PSE 180ma	2.5K-4/8 ohm	$265
75 W for 211/845PSE 240ma	5K-4/8 ohm	$290

PP = Push-Pull, PPP = Parallel Push-Pull, SE = Single Ended, PSE = Parallel Single Ended. UL = 43% Ultralinear taps for Dyna Mark III, etc.

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MY WAY

Yo, Rap-Master Joe,

Just received *SP 3* and I dig it the most. But, I do have a problem with what has become a more or less recurring theme in *SP*. To whit, the question of what hi-fi is all about. The basic theme at *SP* seems to be that hi-fi is about getting the sound that you like. And indeed, on the face of it, this seems an easy perspective to support. But let's look a little deeper. Let's do a little vertical thinking, and see what we dig up. In your reply to Frank O'Connell-san you say, "Hi-fi is always a LIE." Gee, lighten up Joe.

Well 'tis true I suppose, the original event will never occur in your listening room. There's a small matter of space and time, if you get my drift. Could be the performers are all dead, you know. But to me, the point is how close can you get to an accurate recreation of the event? Now, anyone who's seen a real sunrise can tell the difference between its blinding radiance, and the image of one that's been captured on film, and projected onto a screen. The distinction is that with the sunrise we have a daily reference. With music/audio it's a lot tougher; very few of us are lucky enough to get a daily dose of live music, though we'd all be healthier if we did. The *SP* rap seems to say, "If you don't know/like the original sound, then make it sound the way YOU like."

Let's drop the audio thing for a second. We're getting too damned sweaty about all this. Let's say we're talking about color slide photography: would you want a projector that showed your slides, be they good or bad, accurately? Or, would you prefer a projector that subtly deepened the blues and softened reds, resulting in dramatic blue skies and warn skin tones? You'd oooh and aaah at the pretty colors for a while, but in time you'd be looking for the truth.

The "My Way" approach to audio harms me not at all. Still, it's not high fidelity, its "my fidelity". Yeah, I know. Someone else said it first; I just can't remember who it was. Anyway, me, I need fidelity. I want to know what recordings really sound like, and just how bad (or sometimes good) my slides look. If the world were filled with systems that always made their owners feel warm and fuzzy, the recording process would never improve. We would all just bask in the warmth of a false audio sun, having no idea of the brightness of the real one.

But, like I said, it doesn't bother me. I'm just looking for you to be up front about it. Drop the hi-fi moniker and embrace you most favored colorations and distortions. Why not get yourself some tone controls, an equalizer (maybe one with lots of pretty lights?), some old DBX compressor/expander, a good ol' SAE pop and tick remover, and maybe a bass synthesizer. If you're bent on the damnation of fidelity, why not damn it good?

Man, I'll defend you. Just like I'll defend your right to wear plaid, vote for Republicans, bungee jump, watch hockey, eat pork rinds, buy polyester blend jeans, listen to show tunes, drink Diet Coke, and microwave a good steak. I'll be there for you. Just be straight with us.

The current audiophile correct attitude can, at times, be even less defensible: at January's WCES I heard some of the most blatantly distorted and colored sound that I've ever been victim to. Most of it erred on the side of brightness, it's true. But a lot of it was quite simply too pleasant. Rolled and rounded. Saxophones with no edge, trumpets without bite, or aggression. I mean, I played the trumpet for years; at a distance under 40' it can actually hurt. At the same time, I reject gear that adds its own detail. For example, virtually every Audio Research preamp that I've ever heard.

So where does all this leave you and me? Not far from where we've started, I'll wager. Still, I do maintain that everyone who's into hi-fi for the right reasons ought to be getting their RDA of real music, I don't care whether it's Arrested Development or Brahms. Just go hear it. Otherwise, it is all too easy to forget the sound, feel, and impact of the music that you love. The pursuit of high fidelity may indeed be a futile one, but it's still worth an honest effort.

Paul A. Cervantes
The Audio Observatory

Paul, my man:

I hear ya'. You know what you want. You listened hard, you were honest with yourself about what you heard, and you defined what you're looking for. Now you're trying to get it. That's what it's all about.

Let's get a bit philosophical for a minute. By definition, there is only one kind of *perfect* fidelity. If it is *exact* reproduction, it's exact reproduction and that's that. But if perfect fidelity is impossible (or unattainable presently), then it seems to me that different sounding systems can reach the same "level" of imperfect fidelity, even if they are imperfect in different ways.

So, if you can't get a perfect "10", I argue that it's okay to choose the "8" or "9" that you like. Let's say there can be a "slightly bright and edgy 8" and a "slightly warm 8". Of course, this line of reasoning gets away from the goal of perfect fidelity. But how do we choose among the flawed systems we all have to live with until "10" comes along?

Because a musical performance is a highly complex, multi-dimensional experience, fidelity has many dimensions. Every system does some things better than others and certain aspects of music are more important for a given listener than others. The thing I am trying to recapture is "emotional fidelity", as I'll call it for lack of a better term. Give me a system that will make me boogie, space out, ponder, or what ever the music wants me to do. I like an illusion of "person-to-person" communication, a sound that lets me relate on musician-to-audience terms. Few systems do it for me and I sometimes find it hard to find a common thread in "objective" sonic terms among those that do. However, when it happens, *I like the sound.*

Anyway, I consider it to be significant that as soon as somebody mentions "sound you like," card-carrying Audiophiles revert to the trusty 'warm and fuzzy' argument. Why can't there be a "sound you like" that is true to the original? Can't a listener actually have good taste and like a sound that approaches fidelity? Or are audiophiles *required* to suffer while listening to fancy reference quality systems that they don't really like much?

The big question is "Whose fidelity do you want anyway?" It's an issue of "reasoned choice" vs. being a high-end zombie. The quest for fidelity is mostly about understanding, exploring, and fulfilling our individual tastes, perceptions, and aesthetic values. Through our attempts to reach perfect fidelity, we can learn to know ourselves better and find expression for our personal values. The hi-fi quest is about the journey as much as the destination.

I'm right next to you looking for a "10". If you find it, let me know—call collect. In the meantime, I'll just fire up my trusty SE amps and live with an "8" or "9" that I like.

RING DEM BELLS

I read Herb Reichert's "review" of the Audio Note caps and transformers in *SP #3* with interest. "Wrought by a single hand", eh? I am more than pleased that Herb has noticed that, I think that when you hear more of what we do you will find that to be very true.

One comment that Herb made was closely the same as what we have found, that AC signals are electromagnetic "shockwaves". I think that there is more to that than most audio engineers realize. To give you an example, when I started looking at capacitors in 1979, we devised the following test:

Connect a capacitor over the output terminals of a stable power amplifier, then connect a frequency generator to the input, and set the volume level at about 1/4 to 1/2 volume. Then run a frequency sweep from 0-20/khz into the amplifier. All the plastic capacitors that I've tried sounded like small (very small) loudspeakers, the paper caps were almost silent. We employed sensitive listening devices like medical stethoscopes for these tests. The frequency at which a capacitor resonates under these conditions closely matches the colouration it introduces into the sound of the amplifier when used in the signal path.

This is not a finite, conclusive test by any means, but a good and quick way of disqualifying most contenders. On the subject of feedback, the electromechanical "shockwave" theory may also have some mileage; when I have time over the next few months I shall run some tests and formulate some thoughts on this subject.

Peter Qvortrup
Audio Note UK

KLIPSCH

Dear SP:

I just received the most recent issues of your magazine. I think they are wonderful and contain very interesting articles, ones we all have been looking for these days.

One thing I don't understand, however, are the negative references and reviews of Klipsch products, such as in Greg Boynton's "What About Horns?" in *SP #1*.

Department of Corrections

Changes to Issue #3

6BX7 TRIODE AMPLIFIER (p. 11)
The 6.3 filament is shown grounded in two places in the schematic diagram. Choose ONE grounding arrangement.

READER'S FORUM:
Reply to O'Connell-san (p. 34)
The Silver Night is a *push-pull* amplifier (called *super-linear* by the designer) and not a parallel single ended amplifier as reported. This mental slip provides strong evidence for O'Connell-san's argument that Roberts-san has single ended triodes on the brain.

Mr. Paul W. Klipsch has been involved in the audio-industry for a very long time and has witnessed the evolution of sound reproduction from its beginning.

The Klipschorn has been in uninterrupted production since the 1940s and it is still recognized worldwide for its design and sound qualities. It is also the most copied loudspeaker in the world.

While the audio community kept pushing for change, and witnessed the introduction of the transistor, the direct radiator speaker, electrostatic and planar speakers, and so on, Mr. Klipsch continued to promote the horn-loudspeaker, making sure that horns were not forgotten.

So before selling it all to the Japanese, as happened with Marantz, McIntosh, etc., you should better appreciate your American heritage. We in Europe do.

I get very good results with the Klipsch La Belle, a 1975 model, which I use in combination with the L'Audiophile 300B Legend mono-blocks.

These French triode-tube kits are from the Maison de L'Audiophile, in Paris, and were designed by the famous Jean Hiraga. They use an original Western Electric 300B triode and the Partridge TK4519 output transformer, filter choke and power transformer.

As a pre-amplifier I use the McIntosh C 28, because it also has an independent center-channel output, for 3-speaker stereo. For your information, Mr. Klipsch has mentioned and favoured a 3-speaker-array in his "audio papers."

This can be done with 3 electrical true independent channels, as introduced by Bell Telephone Labs in 1934, or as a 2-track, 3 channel by means of a phantom circuit, where the center channel speaker is an acoustic mix of the left and right channels.

Enclosed is a Reference Listing from a German audio magazine, where you will find the Klipschorn ranked in the top category.

Henk B. De Ruiter,
Giekerk, Holland

Dear Mr. De Ruiter:

Of all the correspondence we receive, some of the more passionate mail has to do with Klipsch. Many serious and experienced listeners swear by Klipsch speakers, particularly the Klipschorn.

Well, a group of us recently listened to a pair of Klipsch La Scalas powered by some small triode amps as part of a high efficiency speaker survey for SP #5. We thought

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they were really good. And, yes, we were somewhat surprised. Pleasantly surprised.

I came up with several untested theories on why the big Klipsches aren't favored by typical American tweak audiophiles.

—They never heard them (at least not with an appropriate low power tube amp)
—They are hopeless snobs and Klipsch speakers aren't fashionable in certain elitist audiophile circles.
—Klipsch are viewed as "old" designs and, in our culture, there is a tendency to break with the past and subscribe wholeheartedly to the illusion of "progress."

Of course, there are probably some who gave Klipsch speakers a serious evaluation and simply didn't like them as much as something else. To each his own. But, as you suggest, if more high-end types gave Klipsch speakers an honest chance surely many would find that they like them quite a bit.

Contrary to the stereotype you mention above, there are *many* in the US who value our classic products. Greg Boynton is certainly one—he studied every paper Klipsch ever wrote. He has the greatest respect for Klipsch's work but he wants to time-align drivers 1993 style. He values solid contemporary practice as well as the classics. A good healthy attitude, I think.

Of course, the number of "historians" is small compared with the total US audio buying public—not to mention the total population. How many Europeans really care about classic audio gear, regardless of where it came from? There are individuals everywhere who recognize quality and it's certainly true here in the States.

As for the Japanese, I congratulate them for recognizing quality and getting a good deal on the purchase. There's still plenty left for the rest of us who know what is good. Sure, prices are higher thanks to Japanese interest—but that's life in a free market world. Looking on the bright side, North American and European enthusiasts can occasionally unearth a real bargain. Recently, I found a few nice Western Electric speakers for $5 each. That would *never* happen in Tokyo!

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by Joyce

A DAY AT THE HAMFEST

So you married an audiophile. Your friends and family try to comfort you and say, "Look at it this way, you could have married a gambler or an ax murderer instead." But you know better. What, you ask yourself, could possibly be worse? Let me tell you, I know. You see, I didn't just marry an audiophile, I married a ham radio fiend.

Like some kind of modern day werewolf, my man looks like a regular audiophile by day, but come dusk he disappears into the attic with his radio and his antenna and turns into a *ham*. He's gone for hours every night and I don't know what he does up there, because all I've ever been able to hear is a lot of static, some loud crackling and maybe a few snippets of conversation such as "You're 59 Virginia, WX is sunny, running a HQ-792, QSL." Oh boy.

Audio may rule the day, but the night, the night belongs to Ham Radio. Unless, that is, the next day is a Hamfest Sunday, in which case he'll get up at the crack of dawn to reach a swap meet where he can rub shoulders with others of his kind and check out ham radio gear. You can imagine my shock when he asked me to go with him the other day, because, he said, he was actually going to get rid of some stuff (hallelujah!) and he needed someone to help him watch his stand. How could I refuse?

We drove for hours down winding country roads before arriving at the entrance of the Hamfest (a.k.a. the home of the local Agricultural Fair) where we were met by at least 20 members of the local Civil Air Patrol, all of them hams. The cadet selling tickets glanced into the car and sold us one ticket, "No charge for the XYL," he said, and waved us on to the parking area.

That's ex-young-lady in ham-talk, and just one of the many mysteries of the hamfest. It took my husband 46 seconds to unpack the car and abandon me to the unknown perils of selling radio parts and gear with a simple, "I'll be back." I am left alone to sell four boxes of tubes, two boxes of radio parts I don't know what they are, a few miscellaneous drivers, transformers and books, and a classic 1960s Collins S-Line receiver.

By now its 6:30 in the morning and a lot of people are starting to pass by. I sell a few tubes and parts for a buck apiece. Then an old man comes by and carefully checks out the Collins receiver. He lovingly opens the top, inspects the workmanship inside and turns towards me, "What's your husband's name? I think I sold him this receiver. What's he selling it for?" "Two-seventy-five," I answer, and the old man shakes his head. "Nice radio," he says, "I know, because I owned it," and walks away.

Maybe I'm not so good at this hamfest selling. I observe the guy next to me, who is hawking obsolete satellite receivers. He loudly calls to passersby, "Everything is five dollars, that's right, five bucks takes anything!" When a potential customer asks, "That's so cheap, do they all really work?" my neighbor doesn't miss a beat, "Its a fifty-fifty chance, sir. Maybe half of them work, half don't. But at that price, you could buy ten! The odds are with you. How can you miss with a deal like that?"

Finally my husband returns, and I tell him about the old man who came to look at the receiver and thought it once was his. But my husband says he got the Collins receiver in trade from Keith, who got it from Mike, who got it from Steve, who maybe got it from the old man. While I'm still trying to memorize the distinguished ancestry of our Collins receiver, my husband disappears, as mysteriously as he appeared.

For another hour, more hamfest characters come by, some to look, some to buy, and some just to chat. Steve, an old radio buddy stops by and I ask him about the Collins. Yes, he was the one who bought the radio from the old man, who then sold it to Mike, who, by the way, didn't sell it to Keith, but traded it to Dennis who owed Mike for some gear, but since Mike himself owed Keith from another deal, he was the one who sold the receiver to my husband.

I sell a few more items and am still trying to mentally sort out the Collins history when a voice over the public address system interrupts my thoughts, "Ladies, we remind you that Bingo is about to begin, free of charge, in the bovine pavilion. That's right, ladies, free Bingo courtesy of the Lyons Club."

A few more people stop by to buy parts and the old man reappears. He runs a proprietary hand over the Collins chassis and says, "Your husband still running around? When he comes back, tell him I'll give him 125 for it." and walks away. Another man stops to look at some parts marked 25¢. "Will you take 10 cents for these?" he asks. All of a sudden, playing free Bingo in the cow pavilion sounds like an excellent pastime.

My neighbor is still calling, "Five bucks takes anything!" A man stops by, takes a look at all the ancient tubes and parts I have for sale and asks, "So who died?" I am startled and just stare at him. The man steps closer and asks more loudly, "Who died? Whose estate is this a part of?" Nobody, I explain, it's my husband, he's into these things. But from the suspicious look on his face when he left, I'm not sure he believed me.

Another old timer checks out my wares and is about to pass on when he does a double take and picks up a silver painted transformer looking thing. A huge smile transforms his face. "You know what this is?" he asks. I've no idea. "I was a railroad man myself," he proudly tells me, "worked up and down the line in '38. This here's a W.E. repeat coil, used to use 'em everywhere." "Would you like one?" I ask. "Nah," says the old timer, and walks away, the smile still on his face.

My husband finally comes back to relieve me and I get a chance to look around the hamfest. Half an hour later when I come back, I'm just in time to see the old Collins radio man leaving with his newly reappropriated S-Line receiver. I notice a certain spring in his step. No wonder, I realize later. His radio went through five different hands, in three different states, and he not only managed to get it back, he also made some money on the deal!

Next I discover that my man has spent all of our profits. The car is once again packed to the gills. The money I got for the mysterious parts I've spent all day selling has been converted into other, equally mysterious parts. The back seat is now taken over by another large receiver, twice the size of the old Collins S-Line.

Believe me, the man is a maniac. A friend once said, "He would rather see a 5692 in a perforated tube shield than Cindy Crawford in a string bikini." I'm afraid the truth is even worse; I suspect he would rather see the 5692 in a string bikini.

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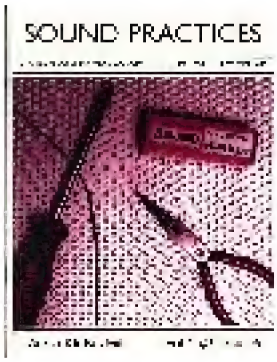
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SOUND PRACTICES

A JOURNAL OF AUDIO TECHNOLOGY SPRING 1994 FIVE DOLLARS



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. . . AND MUCH MORE !!!

The Triode Renaissance

After many years of popularity among elite Asian and European audiophiles, the single triode amplifier has finally captured the fancies of a few prominent UK and US audio journalists. I don't mean to suggest that we're slow on the draw or anything, but as anyone who has ever heard a well-appointed triode system understands, it was only a matter of time before "triode fever" caught hold in the Atlantic world. A good single-ended triode amplifier is a wondrous thing.

Like anything else, triode amps are not for everybody. But a lot of listeners are discovering — often to their great amazement — that the triode sound is just what they were looking for. Partnered with appropriate speakers, triodes do all of the audiophile things with grace and precision. Although triodes excel at three-dimensional presentation, the greater weight and presence of triodes shifts the basis of listening from the "high end" photographic/visual aesthetic of imagery and detail to physical, immediate, and direct apprehension of music. It's funny that you can attain heights of presence and impact with a tiny amp and sensitive speaker well beyond what most 82 dB speakers powered by 500 Watts produce.

Think about it. There has to be a good reason why for decades some of the world's most serious audiomaniacs have been investing large sums of time, money, and emotional currency in creating systems around single triode amplifiers. They never seemed to care that the 300B tube was obsolete or that a 2A3 puts out as much power as a two dollar chip. Unless the many thousands of seasoned audiophiles who "went triode" are free of reason and taste, there must be something to this strange business. If it were simply a whim or fad, the triode wave would have died off long before it reached us. In spite of low power and generally unimpressive measurements, single triode amps are exploding in popularity in markets where fifty watts used to be considered a bare minimum.

Given prevailing conceptions about the necessity of big power, the high profile players in the first triode wave are big monster triode amps — *Ongakus*, *Yoshinos*, *Cary 805s*. A *big* amp in this context means well up in the two digit power range, something that seems reasonable to hook up to a "modern" speaker. In this respect, a 211 amp or an 845 amp is a capable ambassador for this new/old technology to an audio culture where high power is the usual way of getting the job done. In the context of what we *think* we know about musical reproduction, it's hard to take a three watter seriously. Until you hear one, that is.

Perhaps it has to do with traditional conceptions of manhood in our culture or something. Maybe it's an undiscriminating "more is better" attitude. The reality is that killer single triode amps come in all sizes: from milliwatt jobs which will only run hyper-efficient horn tweeters to fifty watt class behemoths. The big triode amps in vogue today may be great stuff, but they constitute only a small corner of the total triode universe. In other audio cultures, the low powered triode amp proved to be the small ax that cut down the big tree.

One phenomenon which accompanies and propels the triode amplifier as it moves around the globe is the growth of DIY. After decades of appliance consumer mentality, we are beginning to see this in American and European audio circles. Triode amps, especially small simple ones, are the ultimate amateur constructor projects. Glorious sounds can be yours with five resistors, five caps, two tubes, and a set of transformers. Anyone of average intelligence willing to work and think can build a simple triode amp. Not only can you get maximum sound per dollar when you roll your own, maybe even ultimate sound *period*, you get a whole range of new rewards from audio when YOU build it. Many newcomers to DIY are finding that the time invested in learning the basics of building is the best audio investment they ever made. This is what the triode renaissance really has to offer us, aside from great sound — a path to new levels of involvement and new ways of being an audiophile. Try DIY. It can change your world.

A DIRECT COUPLED SINGLE TRIODE AMPLIFIER

by Ciro Marzio and Cristiano Jelasi



The Loftin-White Circuit

The outstanding characteristic of this amplifier from a technical point of view is the use of a direct coupled circuit — that is, no capacitors or coupling transformers are used between stages. It is basically descended from the classic Loftin and White design presented for the first time in 1929 in the well-known American magazine *Radio News*. This article caused a sensation not only because of the measured performance of the amplifier, which was exceptional for the times, but also because of the extreme simplicity of the design.

The original Loftin-White amplifier had a frequency response extending from 50 Hz to 10 KHz at -0.5 dB without making use of any form of negative feedback, an innovation invented only a year earlier. In addition, the "comfortable" (in those days) output power of slightly more than three watts, makes the amplifier's great success easy to understand. While the design rapidly spread among hobbyists, it was also commercialized, ready-made or in kit form, by many companies.

The original Loftin-White (Fig. 1) used a 224 tetrode (the predecessor of the 24) in the first stage and a 250 triode (the predecessor of the 50) in the output stage, achieving an elevated gain of about 50 dB for use with phono input. Our amplifier will use all triode gain stages and it will provide an appropriate measure of gain for use with typical line level sources.

We realize that presenting an amplifier based on a design developed sixty five years ago may seem strange to many of you, but to this day this circuit topology provides an unsurpassed musical performance. The popularity the Loftin-White circuit enjoys among Japanese audiophiles and experimenters is enormous, and even in France this classic circuit is highly regarded among extremist audiophiles for its great musicality. According to Jean Hiraga, one of the main popularizers of this type of amplifier in Europe in recent times, approximately 30% of homemade "audiophile" amplifiers built in Japan during the 1970s and 1980s were Loftin-White types.

Our Loftin-White

A monophonic version of this amplifier has been part of one of the authors' home music systems for a long time. This design was built to listen to music, not for presentation to other experimenters as a construction

project. However, since the circuit is not excessively difficult, we decided to present it practically without modification.

They way we built it, the amplifier has some specialized features. Our "prototype" is constructed in such a way that it can be converted for a variety of tube combinations with a few simple changes. This feature requires specially wound power and filament transformers. Most would choose to set up the amp for particular tubes and then forget about it.

Output Tubes

There are numerous possible candidates for the output stage. We decided against using famous power triodes such as Mullard PX4, Telefunken RE604, Mazda PP3/250, Western Electric 275A, etc., which have valuable sound characteristics but are too difficult to find for our purposes.

There are a number of more accessible tubes, including: 2A3, 6A3, 6B4G (which differ only in the voltage of the filaments and the bases), VT52, 300B, 842, 10, 10Y, 801A (the last three are succeeding versions of the same tube), 45, and 50. Of these, the first five have internal impedances of circa 700-800 ohms and work best into loads of circa 2500 ohms. The last six require higher values of primary impedance for the output transformer.

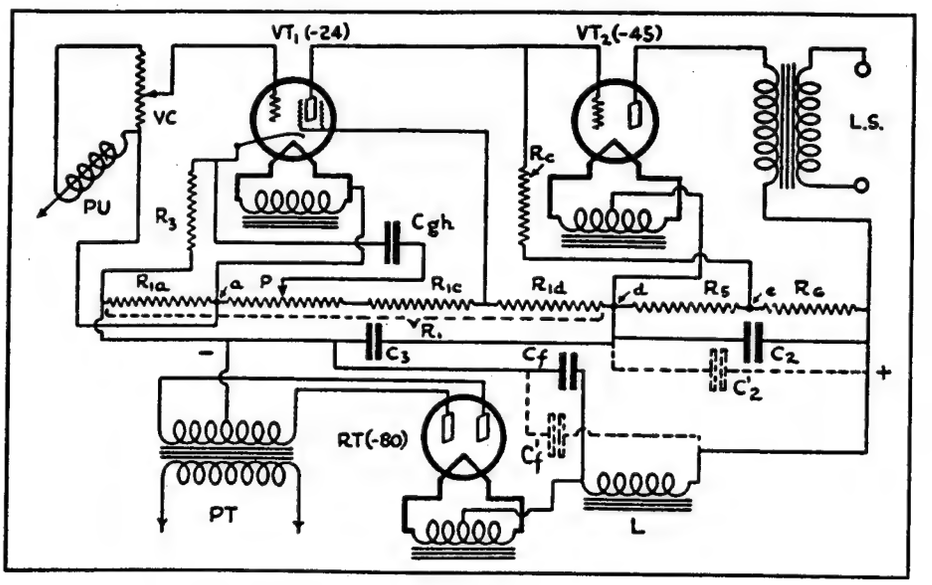
In general, the construction of a high quality output transformer is less problematic as the impedance of the primary is lowered. In other words, quality being equal, an output transformer with a lower primary impedance costs less, at least among the models of the same maker. Given these considerations, we chose to go with the lower plate load tubes.

The old U.S. made versions of the 45 and 50 tubes provide subjective performances of high levels, but are they are very hard to find. Performance is slightly inferior in the Chinese versions, which are easy to find and are still in production. Let's consider the candidates one at a time:

2A3 - There are two versions, a relatively rare mono-plate version and the more common bi-plate version which is actually two elements mounted in parallel in the same envelope. The mono-plate version was made by Fivre and Brimar and is characterized by a more airy sonority, rich in harmony and of great introspection. Mid and high ranges are absolutely superb, the low range is profound and well articulated. This is absolutely one of the most musical directly heated triodes.

The Fivre version is the most celebrated of the two mono-plate 2A3s, having a very particular filament structure. Twelve filament sections are arranged in parallel on a rectangular frame, a design feature which some argue is responsible for its wonderful sound. By the way, the Telefunken RE604 has the same filament structure and it is the only triode we know of that's able to reach the heights of the Fivre 2A3 single plate.





The original Loftin White circuit

Aside from the desirable frequency characteristics of directly coupled circuits, the Loftin White design offered significant economic advantages since no high voltage coupling capacitors were required. In those days, high voltage capacitors were costly devices. In the circuit pictured above, further economy was realized through the use of low value (1 mF) filter caps in conjunction with elaborate electronic hum balancing measures.

← **A 1930 advertisement for a "new and amazing" Loftin-White amplifier kit based on the venerable 45 output triode.**

The bi-plate version does not reach the same summit: the inevitable difference between the two parts making up the tube renders the sound a little less limpid — the bass is slightly inflated, the introspection of the highs less developed, and the details not fully focused — in short, it is a little euphonic. However, the listening results are much better than those obtainable, for example, with a KT88, a 6550 or a EL34 mounted in pseudotriode. The bi-plate 2A3 is easy to find and it is still being produced in China. The sonic difference between the old western-made tubes and the Chinese ones is not particularly marked. Nominal output power of 3.5 watts.

6A3 - Like the 2A3 but with filament voltage of 6.3 Volts instead of 2.5 Volts. There are mono-plate versions of vintage American and contemporary Russian production.

6B4G - Like the 6A3 but with octal socket instead of 4 pin UX4. Only bi-plate. Still being made by the Chinese.

300B - The most famous of the directly heated triodes. Owes its fame to the great musicality of the Western Electric version, which is endowed with a full and rich-bodied sound, yet at the same time introspective and analytical. It provides a faithful reproduction of the timbre and color of the instruments, even if not at the level of the Fivre 2A3 mono-plate. However, the 300B is superior in power, articulation, and impact of the low range. Despite its sonic glory, its excessive price (circa 1,600,000 lire per pair) leads us to look at other choices. Western Electric has long since ceased production of vacuum tubes.

The Cetron 300B version, while having a sonic personality similar to the Western Electric tube, is however a bit inferior in richness of harmony and introspection. The performance is nevertheless good but the price, although 40% less than the Western Electric tube, is still decidedly high.

The Chinese versions of the 300B are of slightly inferior performance to the Cetron version. The price of the China 300B is a little more reasonable, but the performance is barely better than that of a 2A3 bi-plate. In our opinion, their use is justified only where an output power approaching ten watts is indispensable.

The nominal power of the 300B is 17 watts, but Western Electric recommended their use for maximum power of 11-12 Watts (per Western Electric specification #1459).

VT52 (45 Special) - Enjoys an excellent reputation for its musicality. Very similar to the WE 300B in the refinement of the sound and the *savoir faire* with which it renders details and nuances of the musical event, but with less authority and articulation, at least in the low range. It is somewhat difficult to find, having been out of production for decades. (ed.—VT 52 is a military number. There is no exact commercial/industrial equivalent.) Maximum nominal power of 4.5 Watts.

Input tubes

With regard to the input stage and driver the choice is a bit easier and, for practical purposes, can be restricted to a few types: those of the 6DJ8 family — E88CC/6922 and the 12AX7 family of tubes — 5751/ E83CC/7025. We have had good results with Philips, Telefunken and Mullard brands but no doubt there are other equally valid versions.

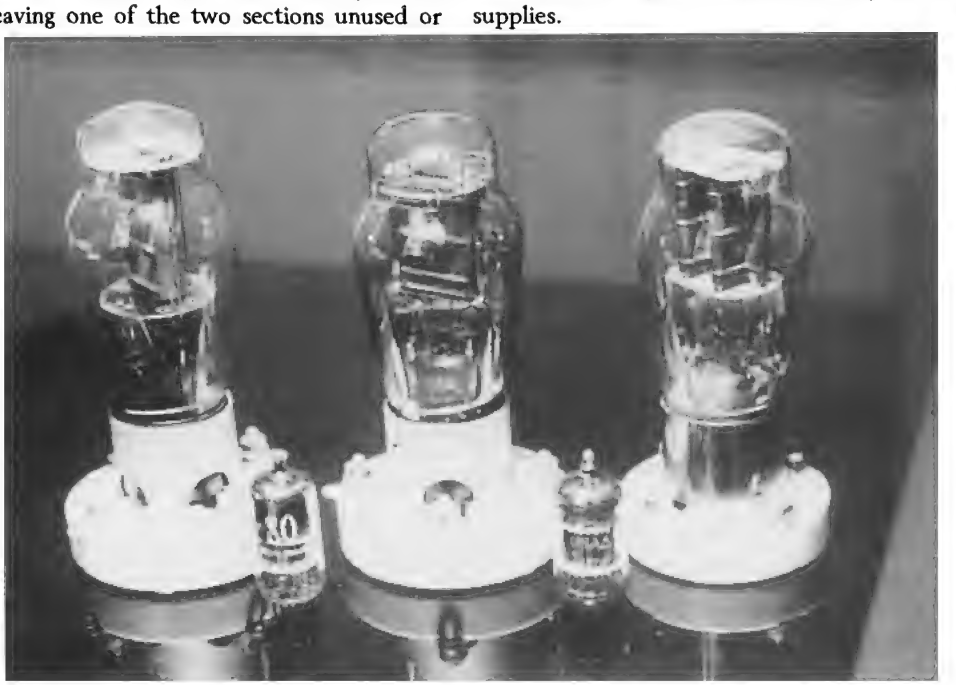
If more gain is required as when driving the amp directly from a CD player or a low output preamplifier, try the 5751 (which has an amplification factor of 70) or, if the gain is still not enough, the E83CC (amplification factor equal to 100).

All driver tubes we have mentioned are twin triodes, therefore you have the option of leaving one of the two sections unused or using both in parallel. To use both sections in parallel, reduce R4 by 10-20%.

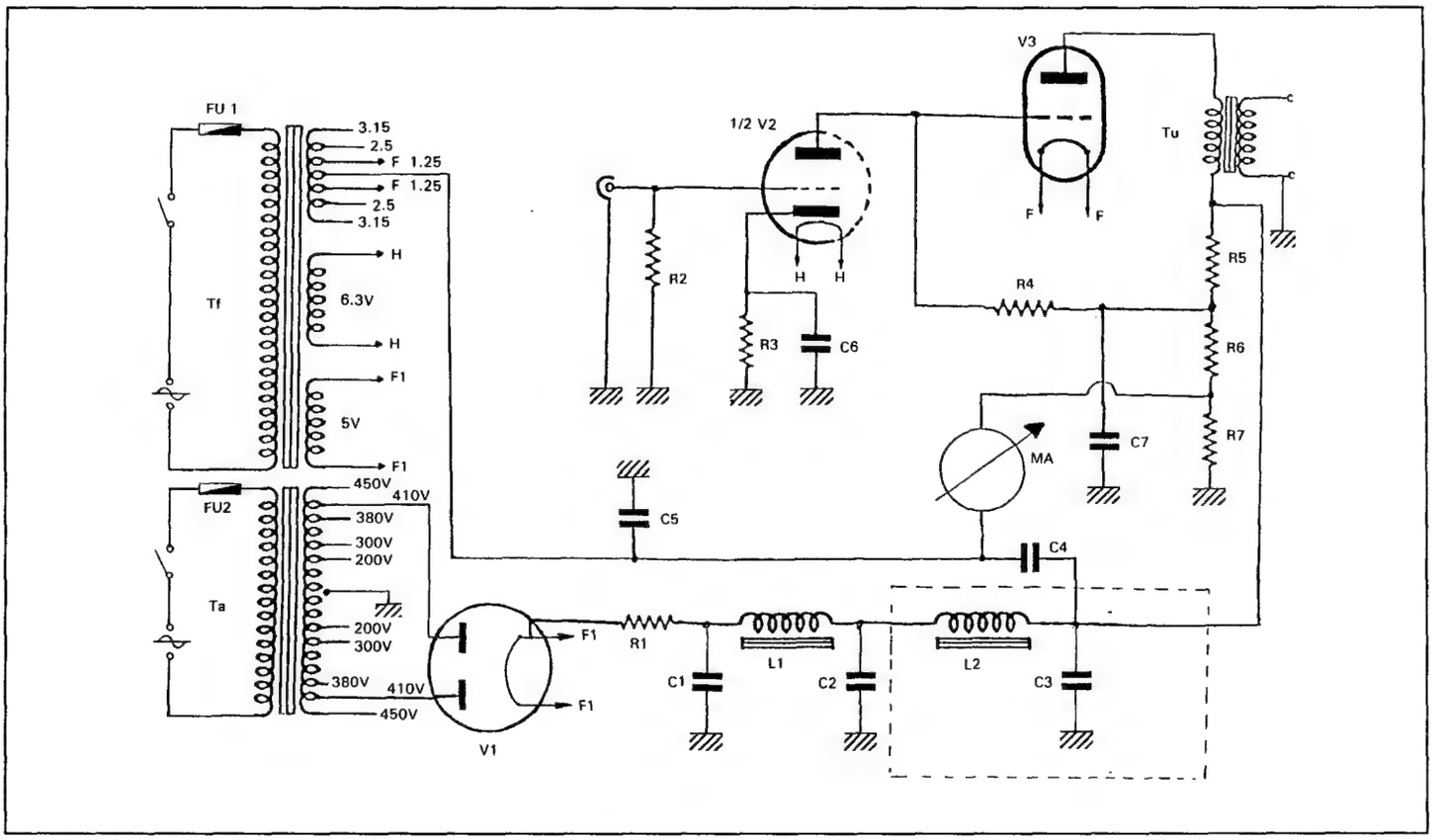
Both solutions present pros and cons. By using both sections in parallel we'll halve the internal impedance of the tube, with a consequent improvement of performance in the low range and lower sensitivity to power supply disturbances. Yet we can expect that we will also have a higher loss of definition the greater the difference between the two sections.

If you want to use this amplifier in a full range application, paralleled sections might be a rewarding compromise, especially for those using the bi-plate 2A3 as final tube — which itself is made up of two triodes wired in parallel. Use carefully selected tubes whose performance between sections is almost identical. The final decision is obviously best made by listening and is left to your tastes. On the other hand, when using the amplifier for high frequencies in a multiamp system, using only a single section should give better results in nearly all cases.

The circuit we present is optimized for the use of the 2A3 — or one of its equivalents driven by a E88CC. You can also use the VT-52, keeping in mind the different voltage ratings of the filaments. The main reason for this choice is the ease of obtaining 2A3s. To correctly use the other input and output tubes, it will be necessary to make some small adjustments in the power supplies.



Three Triodes: Hytron VT-52, Fivre single plate 2A3, garden variety bi-plate 2A3



PARTS LIST

R1	330 ohm	10 Watt
R2	220 K	1 Watt
R3	33 K [2.2K for 6922]	1 Watt
R4	330 K [100K for 6922]	2 Watt
R5	47 K	5 Watt
R6	33 K	3 Watt
R7	3.75 K non inductive	25 Watt
C1	47 uF polyester	630 Volt
C2	100 uF polyester + 0.22 uF paper/ oil + 0.022 uF silver mica	630 Volt
C3	140 uF polyester + 0.22 uF paper/ oil + 0.022 uF silver mica	630 Volt
C4-5	15 uF polyester + 0.22 uF paper/ oil + 0.022 uF silver mica	400 Volt
C6	47 uF polyester + 0.22 uF paper/ oil + 0.022 uF silver mica	25 Volt
C7	15 uF polyester + 0.22 uF paper/ oil + 0.022 uF silver mica	400 Volt
L1-2	10 Henry	120 mA
V1	83	
V2	E88CC/6922	
V3	2A3; 2A3W/5930	
MA	meter 100 mA full scale	
Ta	secondary 2 x 450 Volt, 150 mA	
Tf	secondary 5 Volt, 3.5 amps with tap at 4V; 6.3V, 1A; 2 X 3.15 V, 3A with taps at 2 X 2.5V and 2 X 1.25 V or as required	
Tu	Primary impedance 2500-3500 ohm	

Type	Plate Voltage	Grid Voltage	Plate Current	Internal Resistance	Transcon-ductance	Amp. Factor	Load Resistance	Output Power
E88CC/ 6922	100	-1.2	15	2,650	12,500	33		
5751	100 250	-1 -3	0.9 1.0	58,000 58,000	1,200 1,200	70		
E83CC	100 250	-1 -2	0.5 1.2	80,000 62,500	1,250 1,600	100		
2A3/ 6A3/ 6B4G	250	-45	60	800	5,250	4.2	2500	3.5
VT52	300	-61	44			3.8	2500	4
300B	350 400	-74 -87	60 60	700 700	5,500	3.85 3.85	3000 3000	8.3 11

Pin	E88CC/6922; 5751; E83CC	2A3/6A3; VT52; 300B
1	plate #2	filament
2	grid #2	plate
3	cathode #2	grid
4	filament	filament
5	filament	(absent)
6	plate #1	"
7	grid #1	"
8	cathode	"
9	center tapped filament *	"

Type	Filament Volts	Filament Current
E88CC/6922	6.3	0.3 A
E83CC/12AX7W	6.3; 12.6	0.3; 0.15
5751	6.3; 12.6	0.35; 0.175
2A3	2.5	2.5
6A3/6B4G	6.3	1.0
VT52 Hytron, RCA	6.3	1.0
VT52 WE	7.0	1.18
300A/B	5.0	1.2

* not on 6922

Output Transformer

This is obviously an extremely critical component. The quality of design and construction counts much more than a precise impedance value for the primary. We use a transformer primary of 2500 ohms but it is possible to use higher values, up to 3500 ohms. For an amplifier of this qualitative level it is necessary to find a component that is up to the task.

Given the high cost and difficulty in obtaining the best models of manufacturers like Tango, MagneQuest, and Partridge here in Italy, we are happy to report that Elettrica Brenta manufacturers good quality output, plate, and filament transformers suited to this amplifier. Their address is:

Elettrica Brenta
Vico Amerigo Vespucci #2
Fiesso D'Artico (VE) ITALY
39-41-516155 phone/fax.

Passive Components

When constructing equipment capable of attaining high peaks of musicality, the quality of the passive components assumes critical importance. This is particularly true for capacitors. Note that in the list of components, electrolytic capacitors are *not* recommended, not even as power supply filters. We bypassed the high value capacitors (with exception of C1 which is placed in a non-critical position) with others of small capacity in silvered mica and/or paper and oil. This practice is common among extremist experimenters who know how much the quality of these components can influence the final result.

We used metalized teflon condensers made by CSI for C2, C3, and C4. The quality of these components is absolutely stratospheric, but so is the price. Also, they are problematic to find. Truthfully, the difference between these and regular condensers in polyester or paper in oil of good quality is minimal provided they are adequately bypassed by good condensers of small capacity. If you find yourself having sleepless nights over not finding CSI condensers, you can use teflon Siderealkaps or whatever makes you happy.

We suggest that you first build the amplifier using normal carbon resistors (which have the advantage of being non inductive and sounding quite good) or, for higher dissipation, ceramic wire wound resistors. Carbon resistors are considered more musical than metal film resistors by many experimenters, but not by all. Conduct tests to verify your personal preferences. If you feel the need, you can substitute special (and costly) resistors such as Caddock, Vishay, or tantalum film resistors.

If you decide to substitute the input load resistance R1 with an attenuator, remember that the quality of this component will have a determining influence on the final result. Avoid film components here. It is much better to use two-way switches to switch resistances of the right value. This way, there will always be a single resistance (and two switch contacts) on the signal path and one to ground. Needless to say, the quality of the switches should be very high. Given that a set of quality attenuators will increase final cost of the project by 10% to 30%, we suggest you use them only if it is really necessary to adjust the volume at the amplifier input.

To calculate the value of the resistances in an attenuator, you can use the following equations:

$$Rb = Rt \times \text{inv. log } (-A/20)$$
$$Ra = Rt - Rb$$

Where Ra is the value of the resistance in series with the grid of V1; Rb is the value of the resistance of entry to ground; Rt is the total resistance of the attenuator; -A is the desired attenuation expressed in decibels.

A discussion similar to the one made for resistances is in order with regard to cables. To begin with, we suggest using a good OFC conductor, possibly teflon insulated to protect against inevitable encounters with the



tip of the soldering iron. After auditioning the amplifier, if you feel the need to swap wire, you can substitute the initial cabling with esoteric cables in oxygen free silver or other exotic materials. We used cables of aeronautical military specifications in silver plated OFC. They cost less than "signature" cables intended for the hi-fi market and offer high quality musical performance.

When you decide on the placement of the wires remember that you can utilize three dimensions and not just two as in a printed circuit. Try to achieve a tidy cable layout from the electrical point of view first, rather than from the visual: the two do not always coincide. Don't privilege apparent or "cosmetic" order to the detriment of the more important electrical order. Always remember that the ground leads must converge at one single point near the input to avoid the possibility of promoting various sources of hum.

Filament Supply

Each of the secondary transformer windings provides alternating current. The secondary of the special transformer we used has various voltage taps with a common center tap. Some builders use DC heated filaments either to eliminate hum problems or to be able to stabilize the voltage. While it is true that directly heated triodes are in fact more sensitive to brief variations in current than indirectly heated ones, we didn't find that the use of stabilized filament supplies provides significant sonic advantages — except perhaps in areas where the AC mains supply is subject to numerous and sudden jumps. We also haven't encountered any serious hum problems using AC filament supplies.

Plate Supply

The plate supply we installed has a transformer with a single secondary with several taps to allow for a choice of output voltages to meet the B+ requirements of various final tubes. The alternating current is rectified through a full wave vacuum tube rectifier.

Our preference for rectifiers is the 83, a directly heated mercury vapor double diode, but nothing prohibits you from using other types of rectifiers such as GZ33, GZ34, GZ37, 5R4GY, AZ50, etc. The listening results obviously differ a little according to the rectifier tube used. The ideal filter would be made up of a two-section "pi" filter, which would result in an insignificant level of residual noise from the supply.

The components in the dotted box on the schematic are for the optional second section. Even with a single section pi filter you will obtain excellent listening results.

Opinions over the sonic delivery of the GZ34 are extremely varied. The well-known journalist Jean Hiraga (editor of "La Nouvelle Revue du Son" and managing editor of "L'Audiophile"), for example, considers its sound coarse and lacking in detail; in contrast, the authoritative Joe Roberts considers this tube, at least the Mullard version, to have a resounding musicality. We must frankly say we are not enthusiastic about it and we consider all the other rectifier tubes mentioned and other similar ones decidedly superior. In any case, with so much difference in opinion the last word must await your own ears; when you have a chance do some comparative listening.

A final improvement could be obtained by using dedicated rectifiers and separate filters for each stage: this would offer a lower common impedance and therefore less coupling between stages. At present, one of the authors is using this arrangement. We are not providing a schematic with this type of dual supply arrangement, but we may do so in a future issue if there is sufficient interest from our readers. Surely in this case the already considerable size of this amplifier would increase.

Preheating the Filaments

In a directly coupled amplifier, the voltages present at the tubes are interdependent and consequently, while the tubes are heating up, the grid voltage of the output tube is wildly incorrect for a moment. The consequence is a brief period of excessively high current through the final tubes. Obviously, such abuse shortens the life of the final tube. To avoid this problem, it is necessary to delay the plate voltage until after the filaments of the tubes have reached normal operating temperature.

Given that we used separate transformers to feed the filaments and for plate supply, the simplest solution is to use separate switches for the primaries of the two transformers. The filament transformer will go on first, followed by the plate transformer after an interval of thirty seconds. Another option is to employ a timed circuit, particularly recommended for the super absent-minded, or for those who have small children or irremediably clumsy relatives.

Adjustment of the Circuit to Various Tube Combinations

The values of the components listed are adapted for use with a 2A3 or VT52 driven by an E88CC/6922. Using an E83CC or 5751 as a driver requires that the value of R5 and R6 be doubled. Plate voltage requirements differ according to the tube combinations used. For the final tube, a difference of cathode-anode potential no higher than 300V is recommended for the 2A3, the 6A3 and the 6B4G, and no higher than 330V for the VT52.

Although the data sheet for the 2A3 suggests a maximum plate voltage of 250V in single ended use and 300V in push-pull, many hobbyists report using 300 volts on the 2A3 even in single ended use without problems of any kind and without shortening the life of the tube.

The maximum plate dissipation is 15 watt for the 2A3, 6A3, 6B4G, 18 watts for the VT52 Hytron, and 15 watts for the VT52 Western Electric or Sylvania. We remind you that to calculate the dissipation of the plate just multiply the plate current by the plate voltage, i.e. the difference of potential between anode and cathode. Don't try any slyness; these values cannot be exceeded without a notable reduction in the life-span of the tubes.

System Considerations

Naturally, source material and preamplification of high quality should be used with this amplifier. Given their extreme transparency, they reveal the sonorous personality of the components which are mounted in the audio chain. Obviously this is true also for recordings; we have found ourselves rediscovering recordings whose high quality we had never realized before because of the excessive zeal less gifted amplifiers subjected them to.

With regard to speakers its a good idea to seek high efficiency systems, especially if you intend to use these amplifiers in full range. In a multiamplification situation, the question of limited power is obviously less relevant. The synergy between these amplifiers and the large horn systems is truly remarkable. The colorization in the mid range of speakers such as Klipschorn and Altec "Voice of the Theater" seems to dilute to the point of being perfectly acceptable. Systems which are already timbrally correct acquire a transparency, musicality, and realism that is extraordinary. Truly extraordinary.

Listening Notes:
We know well that listening notes written by the authors of a project can raise some skepticism, but we will seek to be as impartial as we've been when listening to amplifiers constructed by others. Besides, our long cohabitation with these amplifiers means that we really know their personality.

The first version we listened to has the biplate 2A3 as final tube. We then compared it to the 2A3 single plate. We used this amplifier full range with homemade monitors using JBL components. These speakers have a 95 dB per watt efficiency at one meter and a linear frequency response 3 dB down at 25 Hz. The listening impressions are reported separately for each of the listeners.

Ciro
Version with 2A3 biplate output tube: The midrange is airy and natural, with a good sense of presence and a remarkable musicality. The delivery of the voice is very good, lacking strain or roughness of any kind. The highs are present and pleasant but not overly detailed. Even the bass has good presence and articulation but at times one would want a bit more control. The dynamics and the microcontrast are remarkable even at low listening levels. Despite the reduced output power, considerable listening volumes are reached. Small groups are rendered with good image and detail, although there is some difficulty in distinguishing single instruments of large orchestras, especially in passages with greater dynamic impact.

The musicality of harmony is maintained on a level superior to average. In biamplification service on the mid/high range, the results are better yet. When the amplifier is freed from the task of reproducing the full range, it conveys musicality and naturalness playing the large orchestras and portrays the most demanding passages of the harmonic structure with ease.

Version with 2A3 monoplate: Its as if a veil were lifted and the sound stage, previously already refined and of high quality, reveals details and colors that at first were hidden to perception. The focus of the images is clear, the instruments have well delineated contrast and almost material consistency. The mid and high range are scintillatingly transparent, while the delivery of the lower parts of the spectrum is solid and responsive.

Maybe the bass is not quite as controlled and defined as your better "solid state" amplifiers but this unit offers articulation, a richness of timbre, a truly exceptional naturalness, not far from the fabulous low end performance of tubes like the 300B, the 845 or the 211. Percussion and winds are of a dazzling fidelity and naturalness. The musicians are alive and present on the stage, one feels their breath and movements. The dynamics and the microcontrast are at exceptional levels and the volume of sound is remarkable and apparently slightly greater than with the biplate version.

The large orchestras are naturally reproduced, with remarkable introspection and great rendering of perspective: not only are the instruments arranged on a profound and extensive stage even beyond the speakers, the empty spaces between one instrument and the next are respected. One single caveat: the power is not always sufficient to guarantee a realistic listening level with the most imposing organs. Obviously with high efficiency speakers, such as Klipschorns, this would not be a problem.

In biamplification things improve, elegantly overcoming the problems of power and those minor failings of impact and authority in the low range. The result obtained is of true realism and exceptional enjoyment.

Cristiano
The thing which strikes me the most in this amplifier is its extreme musicality. Hours and hours of listening, with whatever type of music, don't tire one's ears the slightest bit. The stereophonic image is extremely solid and the monoplate 2A3 abundantly extends the scene outside the speakers, reconstructing a stage that is very ample and deep. From this point of view the 2A3 biplate is a little less good.

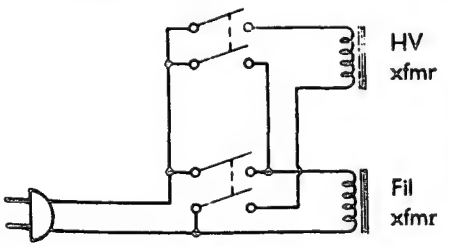
The introspective capacity is exceptional: I've discovered on some particularly "unheard of" recordings that one notices that the musicians are alive, in fact breathe, the pianist from time to time uses the pedals while the contra bassist delicately runs his fingertips over the strings. How to describe with words the emotions felt? More than once, listening with closed eyes, I opened my eyes and was disappointed to find myself not in front of the orchestra, but in front of the stereo. This is something which had never happened to me during listening sessions with notable amplifiers, such as the Audio Research Classic 60.

AUDIO TIPS

Delayed B+ with two switches
In order to maximize the useful life of vacuum tubes, it is desirable to delay application of plate voltage until the cathodes have reached proper operating temperature.

Slow turn-on rectifier tubes such as the GZ34/5AR4 and 5V4 provide some insurance against premature B+ syndrome. In situations where solid state rectifiers are employed or where controlled warm up is essential, thermistors, relays, and thermal time delay switches can be used to control the application of plate voltage.

Slow turn-on is an important consideration in direct coupled amplifiers such as the Loftin-White design. Because operating voltages in the circuit are interdependent, tube-endangering conditions can exist if full B+ hits before the filaments are cooking. You sure don't want to fry any Fivre 2A3s!



A simple but effective way to stagger turn-on is to provide separate switches for plate and filament supplies as proposed in the accompanying article. Turn on the heaters, wait a minute or so, then fire up the B+. Easy enough, but it is not impossible to reverse the desired switching order. It is definitely not a sound practice to switch off the filament supply while the amp is playing!

Shown above is a foolproof method for wiring two switches to two transformers such that the filament or heater supply will be switched first on/last off regardless of the order in which switches are thrown. All that is required are two DPST switches and you'll be ready to fire it up gradually.

This is precisely the great value of the directly heated monotriodes: the ability to make you forget that you are listening to reproduced music. In short, it is the realization of the dream of every true audiophile.

The only negative point: the incredible precision with which this Loftin-White amplifies the signal foregrounds any defect of the other components in the chain. On the other hand, it is very acquiescent with regard to speakers.

Conclusion

At the end of this long description we can summarize by saying that we are highly satisfied. These amplifiers not only allow one to obtain excellent musicality but are also rather easy to build. They answer a quest that — notwithstanding the recent revival of monotriode amplifiers — is not fully addressed by the products currently on the market: that of amplifiers made to bring out the best in high efficiency speakers.

If you begin looking, you will discover that high-efficiency speaker systems are more popular than you would think from reading contemporary audio magazines. It is true that there are too few very efficient loudspeakers available on the market today. However, there are quite a few audiophiles using home made and vintage high efficiency speaker systems with low powered tube amplifiers.

Ignore the fashions dictated by the mass market. As far as pure musical enjoyment is concerned, nothing could be better than building a nice set of single triode amplifiers and hooking up a pair of high efficiency speakers. Enjoy!

The Authors:

Ciro Marzio: perennially divided between the "jobs" of master lute maker and anthropologist. Interested since childhood in everything that makes music. Practically addicted to music. Actively involved in D.I.Y. audio since he was thirteen.

Cristiano Jelasi: Doctoral candidate in International Trade. Extremist D.I.Y.er and stubborn "bricoleur". Began building audio equipment at the age of nine. And never stopped.

Ciro and Cristiano live in Ischia, Italy, where with a bit of luck you might actually find a pair of Fivre monoplate 2A3s!

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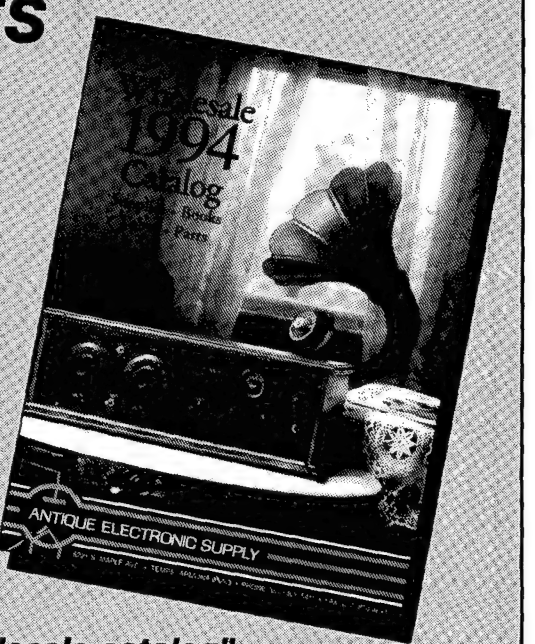
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The Audio Observatory

30339 Abelia Road, Canyon Country, California 91351

Volume 2 Number 4 November 1993

PBJ Interconnect
Kimber Kable
2725 South 1900 West
Ogden, UT 84401
801.621.5530
$62 for a 1 meter pair, and $14 each additional meter per pair. XLR connections are available at no extra cost.

Following a review by *Stereophile's* Corey Greenberg is very much like being forced to follow Robin Williams with a plate spinning act. If there's an audiophile out there who's not read CG's review, promptly crawl out from under your rock and check this stuff out. In essence, PBJ is actually Kimber's fabric shielded KC1 sans the shielding. But in truth, PBJ is among the finest analog cables that you can buy, and one that truly *humbles* a number of high priced pretenders. Let me tell you about it.

First of all, PBJ has a rather unique appearance. Consisting of three braided wires, the PBJ looks distinctly undernourished next to some of the more, shall we say, well endowed cables. This frail appearance is welcome during installation as the PBJ is flexible and easy to maneuver behind components. RCAs, while somewhat common looking, are very sturdy and fit well on every RCA jack used throughout the review period. My only note of concern is that PBJ lacks any type of strain relief. The usual admonition to always pull a cable off by the barrel of its RCA, and never by the wire itself, is especially true in the case of PBJ.

Let's get this out of the way: The performance of the Kimber PBJ rivals *any* interconnect that I've used during the Cable Madness Survey. Whether used between DAC and preamp, preamp and amp, or tone arm and preamp the PBJ always allowed for a remarkably natural and unstrained sonic quality. It's easy to forget about this cable once inserted into a system. It never calls attention to itself, and thereby away from the music. Specifically, the PBJ is very neutral tonally with any distortion being of an extremely minor nature.

Detail is plentiful, but of an almost gentle character. Subtle clues of image and location are always clear, but never etched or pushed forward. Soundstage width and depth, again, rivaled that allowed by any other cable used during the CMS. Best of all the PBJ allowed timbres to be reproduced in a very lifelike manner. Whether a light brush of a cymbal or a muted pizzicato, the beginnings and endings of each note rang true. In a sense, the PBJ is a very hard cable to write about because of its essential and basic neutrality. It must be very, very easy on the signal indeed.

One initial concern that I had with the PBJ proved to be groundless. My system (at the time of the evaluation) required a 5 meter length of cable between the preamp and the amp. In the past I've run into problems with hum when using unshielded cable in this length. To my delight, the PBJ was as quiet as any shielded cable when used in this application. No doubt much of this lack of noise is a function of the braiding of PBJ's dueling ground conductors. In any case, this is one unshielded cable that effectively banished any fear of hum resulting from long lengths of unshielded interconnect acting like an FM antenna.

As regular TAO readers know, I abhor comparing products. Still, I'd have loved to have been able to make the comparison between the PBJ and the Kimber KCAG silver interconnect. My experience with silver cable has been somewhat limited. In the main I've found silver cables to be detailed in the extreme and lacking the nuance and gentility of the PBJ. If the KCAG missed the boat on subtlety one may rightly conclude that although silver is a superior electrical conductor, it may in fact take the back seat to copper in passing the musicality of low level electrical signals.

But enough of my ramblings. Recommending the Kimber PBJ is one easy task. For it would be hard to believe that anyone, using a system of any price, might truly find the PBJ wanting. And, while it goes without saying that I can't name a single interconnect at its price point that can begin to challenge the overall performance of the PBJ, a more amazing fact is that I can't name a single interconnect at any price that I *know* can best it. Kimber's PBJ is an audio classic. Highly Recommended.



KIMBER KABLE
2752 S. 1900 W.
Ogden, UT 84401
(801) 621-5530

DINOSAUR

j.c.morrison, n.y.c.

Mixing romance and technology in the interzone

I had a friend named Larry, he's either in jail or dead now, but his particular talent was riding and working on bikes. Larry built at least four motorcycles that I can remember, each one more spectacular than the previous. Now, when I say bikes, I do not mean any of that motorcycle Zen crap, which is precisely just that: crap. For example, he had an Indian which was so heavily tricked and kinked, that it had no peer for straight line acceleration and ultimate speed. It was bored and ported and tuned and cut and stripped and he remachined his own carbs and cams so that every one of the one hundred and twenty five suicide clutch horses he pulled out of it belonged completely to Larry. The weight was down to 450 lbs. *wet*. He took the corner at the FDR and Houston Street at ninety, which perhaps can only be done by a handful of people on this planet, and he could do it in any condition.

Larry, by the way, loved Beethoven.

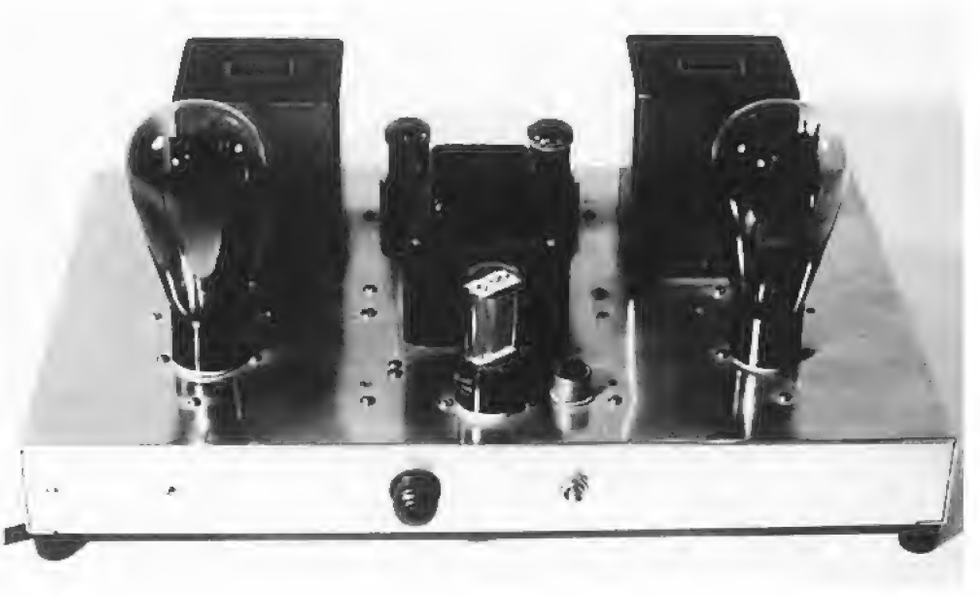
This kind of "combination" art/tech/attitude is something that doesn't usually get much respect (and maybe rightfully so), but perhaps it deserves a closer look. While somewhat difficult to find or experience in *normal* environments, a quick look at the margins of acceptable behavior will reveal all kinds of cool mixings. The prejudice of "normalcy" is all you have to give up to enjoy this stuff. Traditional opposites are not *necessarily* meant to be that way.

Artists and critics have nearly always pretended that they hate each other. Interpretation offends many artists, or at least appears arbitrary and stupid, especially when it comes in the name or spirit of Science. I think this conflict is unnecessary.

Hi-Fi always involves a mixing of "separate" worlds: the practices of the creative artist (the musician and the audio software) and the those of the interpreter (the listener and the audio hardware). This is an especially interesting thing to mull over if you are a designer of audio reproduction systems. In the lingo of the cyber-psychoanalytical-pop culture we love so much, audio design is an *interzone*.

An *interzone*, for those unfamiliar with the concept, is the area where traditionally opposite ideas, practices, or social institutions overlap, usually much to the chagrin of the status quo. (Computer networks, for example). This is always happening, but it has only recently been identified as a potentially valuable human activity. Most people still view such stuff as immoral or dangerous.

American high technical culture, at least the kind which brought you the Hoover Dam and the A-bomb or Apollo 11, is generally big, authoritarian and impenetrable. I like the metaphor of the "black box" in connection with this concept — and I imagine it to be *anodized*. Hi-fi, like most things, has also been seduced away from its down-to-earth beginnings by the power of the "black box" although, as I hope to show, there has also been a counter-seduction, which is a powerful source of hope for me personally. This activity amounts to nothing less than a *counterculture*.



The 1960s counterculture was romantic, anti-urban, anti-science, and anti-tech. But there was always a dark romantic contradiction near its core, symbolized by the motorcycle and the electric guitar. With time, this apparent contradiction has transformed itself. Today, practitioners of these "dark arts" often command remarkable technical skills. Counterculture values remain an important source of vitality and community. Romance, art, and high-tech mix seamlessly.

High Technology has, in fact, radically changed in the last twenty years. Not only is it counterculture tech, it is *visceral tech* — it fits close to the body. Examples are many: the walkman, the PC, the cellular phone, the pacemaker, the soft contact lens, anabolic steroids, the digital sampler, in vitro fertilization, the organ transplant, the cam actuated whammy bar, the UZI, etc. High tech and pop culture are so wrapped up in one another, it's hard to imagine them separate again.

It is in this interzone that audio design has nervously persevered. Droogs listen to Beethoven, remember? They also have been known to dabble with Link Wray and Anthrax. To some it may seem absurd to mix ancient hand-blown triodes with C-core single ended transformers (I love Tango) with trick lamination materials, JFETs, military VHF tubes, Caddock/Mills/Vishay resistors and handrolled copper or silver foil caps, with silver wire and blue-tack all over everything, just to get a little closer to the Billie Holiday of your dreams, but not me.

My desire is to be connected to the music in a *substantial* fashion, and by this I mean viscerally-supported. This "substance" is difficult to articulate and yet we all know when it is not there, as in the case of a person who is clever enough, but somehow lacking in substance. If the music hits you like an ak ak fired up your nose, or if it slides up on you like a lover, if you *change* as a result of listening to your hi-fi, then the hardware is doing its job. I have no use for "background music" in this life! That is my interpretation.

And what is interpretation anyway? Interpretation points, that's all. It points into the big world which is much bigger than any of us. It doesn't finalize or even explain why, it just points us in one direction or another (with no absolute sound). This is why there is no one amp or tube or gadget better than any other. The point is to design your way in with whatever works. The technology that accomplishes what I need is what I work with.

The hundred-watt bipolar current amp with AC and DC feedback belongs to the very realm of power and control technology that the "black box" symbolizes. Certainly something happens when you level its polished barrel at your record collection. It is very effective. Your music has no choice but to submit. And it definitely sounds that way too. Tiny Lilliputian arias suspended obediently between your speakers.

The black boxes the police use to determine how far you ride your motorcycle over the speed limit have not deterred anyone. The illusion of control becomes a little less real and a little more bogus if you simply look at it from another angle. The right technology and the right attitude can take you *around* the policeman, *over* the Audio Puritans, *away from* the tacky materialists and on to different places. This is what art does.

So how does one go about applying this kind of hubbub to the design process? Let's walk through some important design decisions so as to explain by example. To start with, it must use the power transformer I pulled off a Harmon Kardon TRIO 6BQ5 PP integrated so I don't have to look at it sitting on my shelf anymore; it must fit in my beater prototype chassis; and, most importantly, it's gotta be a killer.

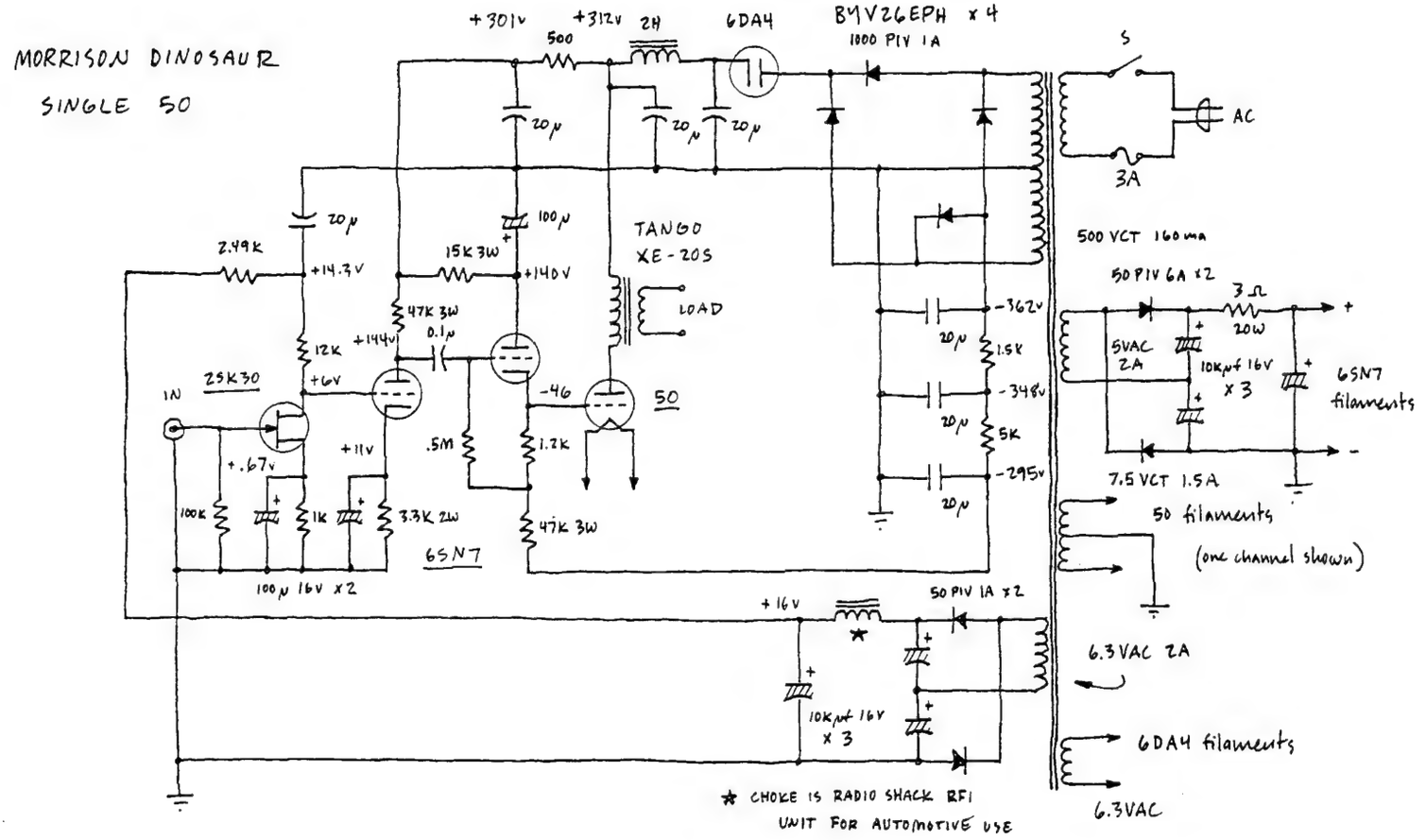
The output tube we are going to meet here is a rare and, in many ways, difficult device to work with. The ubiquitous all-weather 50. By the way, there are no more 50s. They're all in Japan or in the various tube collectors' clutches — tube collectors are the builder's nemesis — so don't bother looking or even wishing to build this amp with a 50. (A 300B will drop right in though, providing you have a 5 volt filament transformer. It will work beautifully.)

The 50 was designed to provide big power (4-5 watts) for single-ended applications. It is a low mu, medium impedance power triode and as such requires considerable grid swing in order to cough up its "paltry" few watts. The solution, in those days, for the problem of getting 90 volts of "high quality" grid signal was a step up transformer. The spacing of the cathode, grid and plate in this tube is optimized for a low input impedance, which limits the grid leak to 10K ohms max. Most interstage trannies have no more than a couple hundred ohms of secondary resistance. I cannot describe in blunt enough terms just how challenging this little prerequisite is. I have personally labored over six driver stages to get to the point where I am now, and although spectacular, I'm still not convinced this new one is the final word. If you do not want to resort to a transformer, be prepared to suffer.

Okay, you say, what's the big deal? Why not just hook it up like they say in the tube manual and be done with it? Good question.

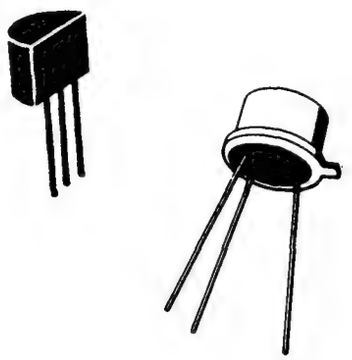


Different kinds of type 50 tubes.



The difficulties come in the following order: 1) big triodes (which the 50 is) tend to have great bass but dark upper midranges and treble (IGNORE the tube manual's suggested operating points); 2) high and medium impedance power tubes are very driver stage dependent (which the 50 definitely is); 3) finding a great interstage trannie is difficult and I have not been impressed yet with what I've heard from such trannies, they usually tend to worsen the upper range of a big triode; 4) most importantly, the 50 has the potential to bridge an interesting gap: its character combines the positive qualities of the low Z power triodes (2A3 and 300B) with those of the high Z power triodes (such as the 10, and 211). While the 45 shares this ability with the 50, and actually does it mo' better, I intend to use this amp with a midrange driver that needs more than the 2 watts available from a single 45!

The nature of this border between high Z and low Z power is, in many ways, a taste thing. The most wonderful aspect of the sound of a tube like the 10 is its utter respect for ambience, nuance and detail. This is the most truthful power tube I've ever worked with. (The 10 and the 45 are my favorites). It can be merciless. If your recording sucks, you're gonna know about it. The 2A3 and 300B, on the other hand, tend to glorify things. This is not to say that they are incapable of accuracy or detail — Komuro and Reichert have so far made me eat my words over and over as regards 300B amps. Still, if the 2A3 and 300B have one thing they do extremely well, it is render the texture, weight and tonal balance of music with elegance and beauty. This, and the comparative simplicity of driving them makes for popular amplifiers.



Different kinds of FETs

I want to have more of what can be had from the high Z triode family. Once again, the thing I am struggling for in designing a circuit around the 50 is to develop its character for walking down a middle line between these two apparently contradictory ideals: accuracy and elegance (which is what we all try to do on some level).

The point is that the tube manual doesn't help out in this situation, and a cookbook approach ain't getting you nowhere. So, you try out every trick in the book and then some. Empirical research is the kind way to describe it.

The basic circuit architecture is shown in fig. 1. There is more than a passing resemblance to Prof. Morikawa's original four stage topology (you may remember Kondo's *Ongaku* also shares this arrangement), which amounts basically to two directly couple gain stages RC coupled to a cathode follower driver directly coupled to the output. *(continued page 16)*

RCA Cunningham Radiotron RADIO TUBES

50

RCA-50

POWER AMPLIFIER

Filament		Coated		
Voltage		7.5		a-c or d-c volts
Current		1.25		amp.
Direct Interelectrode Capacitances:				
Grid to Plate		7.1		μμf
Grid to Filament		4.2		μμf
Plate to Filament		3.4		μμf
Maximum Overall Length				6-1/4"
Maximum Diameter	②	③		2-7/16"
Bulb				ST-19
Base				Med. 4-Pin Bay.
Pin 1-Filament			Pin 3-Grid	
Pin 2-Plate	①	④	Pin 4-Filament	

BOTTOM VIEW

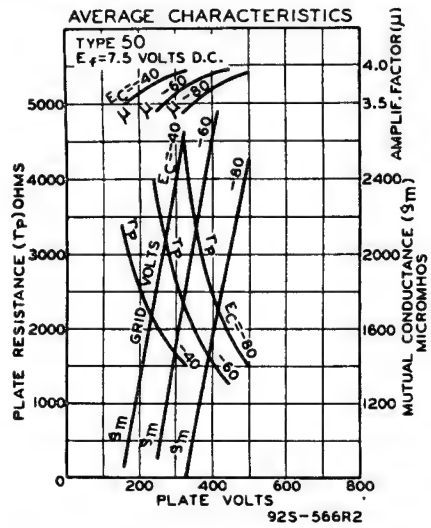
AMPLIFIER (Class A)

Operating Conditions and Characteristics:

Filament	7.5	7.5	7.5	7.5	a-c volts
Plate	300	350	400	450 max.	volts
Grid *	-54	-63	-70	-84	volts
Amp. Fact.	3.8	3.8	3.8	3.8	
Plate Res.	2000	1900	1800	1800	ohms
Mut. Cond.	1900	2000	2100	2100	μmhos
Plate Cur.	35	45	55	55	ma.
Load Res.	4600	4100	3670	4350	ohms
U.P.O.	1.6	2.4	3.4	4.6	watts

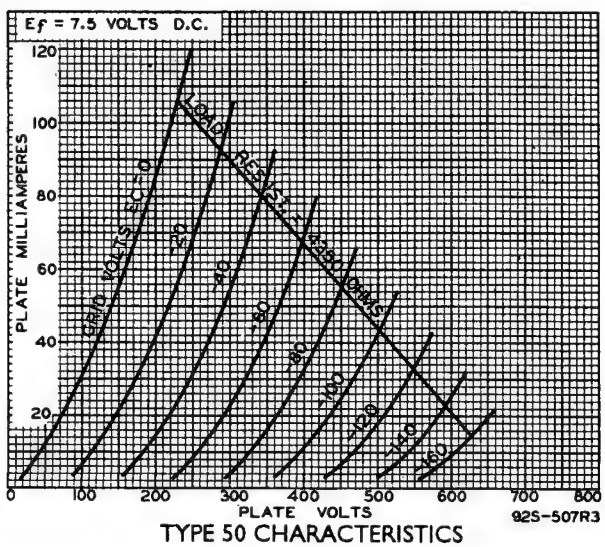
Self-bias is advisable in all cases. The resistance in the grid-coupling circuit should not exceed 10000 ohms.

* Grid volts measured from mid-point of a-c operated filament.



JULY 1, 1935 DATA

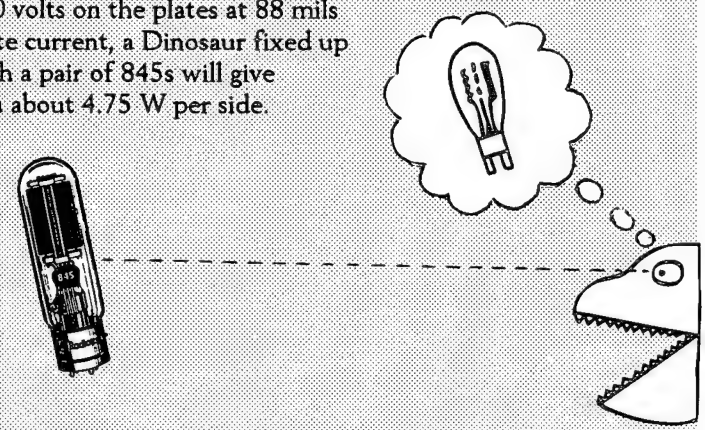
RCA RADIOTRON DIVISION
RCA MANUFACTURING COMPANY, INC.



TYPE 50 CHARACTERISTICS

Feed your Dinosaur 845s!

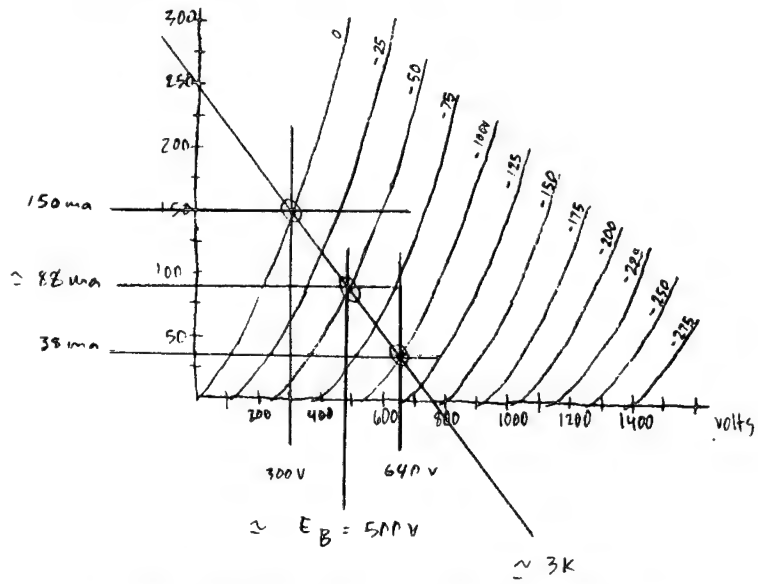
Can't find any 50s? Adapt. Tube vendors now have Chinese 845s at low, low prices. I say get 'em cheap and run them low and hot! The Dinosaur loves 845s. With only 500 volts on the plates at 88 mils plate current, a Dinosaur fixed up with a pair of 845s will give you about 4.75 W per side.



Several changes are necessary to adapt this circuit for 845s:

1 — Increase B+ to 500V. This means a different power trans (800 VCT) and power supply caps rated for at least 500V.
2 — Adjust B- (bias supply) for -50V on the grid of the 845.
3 — Make two 10V, 3.5A DC filament supplies for the 845s.
4 — Increase dropping resistor for driver stage from 500 ohms to 8.2K, 3W.

OPERATING CONDITIONS FOR 845 AT 500 VOLTS



Load resistance = 765V / 250 mA = 3060 ohms
Plate voltage = 500 V Plate current = 88 mA
Neg. Grid volts = 50 Power out = 4.76 W / 8 ohms

I have used the Morikawa circuit before but still prefer simpler, sneakier circuits. In the case of the 50, however, the benefits have outweighed the difficulties and I have come much closer to real satori by employing this arrangement. There are some twists of my own, as you can see.

The B+ supply is 320 VDC. The bias on the 50 is -48 VDC. The JFET has a 13V B+ and everything else should be obvious. The shared power supply is not optimal but I swore I would use up all my dumpster diving parts. The TV damper diode is to provide a slow turn on for the direct-coupled output stage — the 50 warms up much faster than the 6SN7. Yes , I did not put 425V on the 50 for max. power, instead I set it for maximum ecstatic release from ego. The 3.5 watts at 1% THD are all I need.

In summary, here are Morrison's rules of engagement (remember that my criteria are a little specialized and require some things not generally recognized as necessary or relevant):

1) No amp plays all 10 octaves perfectly (I'm shooting for middle/upper frequencies)
2) Burn the tubes up (max current for the voltage applied). This is fundamental to my use of tube technology. If it is sweet, emotional sound you want, set the tube on fire. With few exceptions, high current/low voltage operating points sound clearly better—anyone can hear this. If it means less power/gain and a little more second harmonic distortion (per stage), you will make it up in other areas (circuits or unbypassed cathode resistors, for example).
3) Match the supply voltage to the job. This is really just the other half of rule #2. It means that once you have established the outer limits of current you can drag through your triodes, you find the appropriate amount of voltage swing you need and design the power supply to match, with some headroom left over.
4) Use the smallest possible component values. This is important in terms of bandwidth, transient time and settling time. That means no monster coupling caps, no big load resistances or impedances. Highly touted equipment with mega joule power supplies and feedback are often pointed to with pride in light of their penchant for releasing a torrent of power at the drop of a pin. You will notice, however, that few go on to shout about how long it takes for these wunder toys to recompose themselves. Turning off is one of the most difficult things for an amplifier to do. Where the restoring force comes from has been a topic of heated discussion all century. My opinion is that the charge/discharge time for the power supply should be as fast as possible. I use 20 mF SCR polypropylenes liberally in power supply applications.
5) Silver wire. Yes, it sounds mo' better.
6) Don't pull the same trick twice. Make each stage *complement* the one before.

The use of a solid state device will probably raise some eyebrows, but this little JFET helped me get to a place previously unreachable. The quiet and delicacy this little chip added to the mix was indispensable in taming a hardness the cathode follower has always produced in this arrangement. Think of it as a very small low voltage tube if it makes you feel better about the whole thing.

And that's it. I suppose there's always more, but if I've helped fire your imagination or provided a little insight into what's involved, I'm grateful for the opportunity. Great amps and preamps require heartfelt design, and numbers never tell the whole story.

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	FS 007	SE 807	6000	60 mA	64 Hys.	50W (max)	$350
	FS 030	SE 300B	3000	60 mA	32 Hys.	40W (max)	$300
NEW!	DS 025	SE 300B	2500	60 mA	18 Hys.	25W (max)	$149

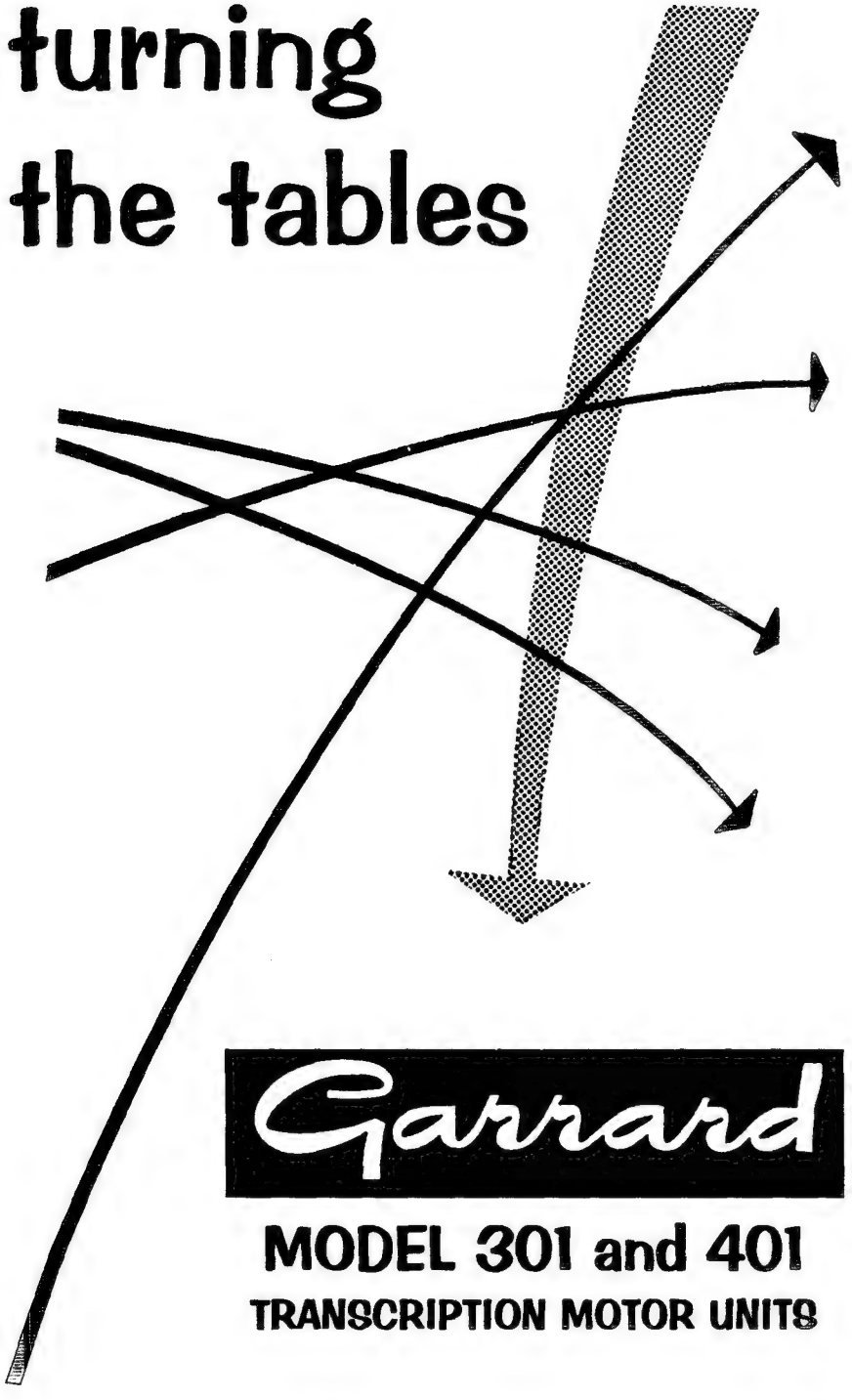
Guaranteed MINIMUM frequency response for all units is 30Hz - 20KHz +/- 1dB.
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turning the tables



MODEL 301 and 401
TRANSCRIPTION MOTOR UNITS

by Haden Boardman, Audio Classics, UK

It's funny how products long since departed to the great listening room in the sky are often capable of showing modern, more expensive items more than a thing or two. Garrard's 301 and 401 idler wheel drive turntables are both prime examples of the triumph of classic designs.

Born in 1953, the 301 was Garrard's first transcription turntable produced to play all three existing disc formats: 78 RPM, RCA's new 45 RPM 7" singles and 33-3 RPM 'Long Playing' microgroove discs. Hence the name — *three*-on-*one*. The 301 was immediately recognized as a reference class instrument. It was to remain at the top of the market for a decade.

The earliest 301s were finished in a classy silver-grey hammertone. These early units had a grease nipple in the side of the bearing. When the deck was installed this reservoir was filled up to the limit with lubricant. All you had to do to maintain proper lubrication of the bearing was to tighten a knurled cap slightly through the access hole on top of the motor plate, thereby forcing more grease into the business end of the assembly.

In early 1957 the finish was changed from 'hammerite' silver-grey to creamy white enamel. Later in that same year the bearing assembly was modified to take oil rather than grease.

Not surprisingly, the earlier grease bearing fitted units are more sought after on the second hand market. The earliest 301s have a bearing made with a phosphor bronze lining as well as thrust pad. Later oil-lubricated units have copper-sided bearings. These have a screw hole on top of the chassis instead of a side mounted grease nipple.

If you are buying a 301 and are unsure of which version you are looking at, the later oil bearing units are marked "schedule two" on the name plate. Most of the grease bearings are fitted to decks finished in silver hammertone paint. Only a few specimens of the cream-coloured version had the "better" bearing.

For years, I did not realize the difference. A friend of mine exports a lot of 301s to Japan. They go potty over a grease bearing and will pay him loopy money for one. For years I thought they were crazy. However, owners of oil bearings need not despair. I personally can hear very little difference between the two bearings if they are in good condition.

The next big change occurred with the introduction of the 401 in 1964. The basic ideas were unchanged, and the 401 is essentially a 301 in a Saville Row suit. The major styling rework was courtesy of Eric Marshall, who had also styled the more mass market 'Lab 80'. The 401 echoed the latter quite a bit. Standard 301 production overlapped with 401 production for a couple of years.



Garrard 301/QUAD rig in traditional overly resonant cabinet

Technically, the 401 offered better magnetic screening. This was mainly because the micro switch was mounted under the motor plate rather than on top of it as in the 301, although the motor casing was redesigned to reduce induced hum in the cartridge. The eddy current brake was more substantial and offered greater variation in speed—just over half a semitone each way rather than just under a third of a semitone. A stroboscopically marked platter which was an option for the 301 came standard on the 401. And for the first time on a British-made turntable, the 401 had a neon lamp to illuminate the strobe markings.

Reading a couple of period reviews in *Hi-Fi News* and *Gramophone* I get the impression that the 401 had a bit of a frosty reception. Percy Wilson, reviewing for *Gramophone*, did not like the styling, complained that the 301 was no worse than the 401 as far as hum pick up is concerned with correct mounting of the arm, and he felt that the 401 offered no overall improvement in performance.

The earliest 401's strobe lamp does not operate all of the time. You had to hold the pitch knob down to activate it. Only a handful of decks were like this. A few years later, the neon lamp changed from the elaborate item mounted under the platter and reflected by a mirror to a plastic window next to the platter to an ugly, one piece thing placed in the hole left by the original's window.

Early in the 1970s, cost cutting really caught hold. The chassis was redesigned. Quality control went out the window as did the finish. Instead of elegant charcoal metallic, you get flat brown. Worst of all, the Garrard logo was changed from a superbly cast emblem to a decidedly low-rent piece of pressed steel. However, these late-model decks offer good performance, as long as everything is assembled and set up correctly.

At the same time Garrard felt the Japanese pinch. Their budget decks (SP25 anyone?) were knocked out of the sales charts by newcomers such as Pioneer's ground breaking PL12D.

The 401 was killed off in 1976. At the same time unscrupulous dealers started flogging smaller, neater junk such as Linn LP12s. 401s came to be considered a joke. The flat earthers were about to have their few years of glory.

Eventually Garrard resorted to badge engineered Japanese garbage. Needless to say they bit the dust in 1982. Quite sad for a company that employed several thousand workers for most of its existence.

At about this time our Japanese friends were building strange tube power amplifiers with quaint tubes like 211s, 845s and 300Bs. A few of them started using older 301s and 401s in preference to some of the imposing Japanese super decks that were on the market back then.

Half a dozen companies set up shop buying unloved Garrard turntables, and other vintage kit on behalf of shops in Tokyo's 'Akihabara'. A couple of these companies are still at it. One reckons there are now more 301s in Japan than back in Blighty.

The main reason these decks were ditched in the trash can was because of incorrect installation. Both decks are fitted with motors of monster proportions. Forget farty Philips VCR motors (as fitted to the LP12) or even the beefy unit fitted to the TD 124. Garrard went well over the top. When the 301 was introduced, 78 rpm records were the norm. This plus the fact that very few pick ups tracked at much less than 10 grams meant that the motor needed to be *big*.



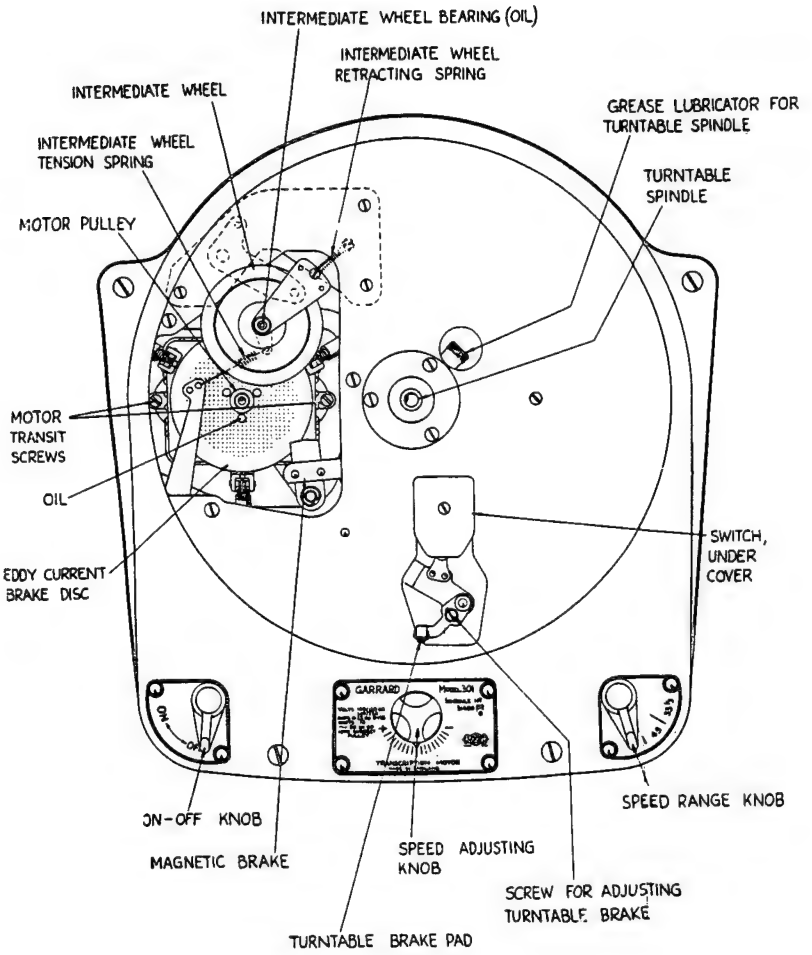
Garrard 401 motor unit with FR-64 and SPU Gold Reference

The problem is that it's a wild and untamed thing. It tends to shake the hell out of the rest of the chassis. Not a problem if your plinth is very heavy and can 'sink' the unwanted energy. Problem was that no one recognized it as a problem at the time. When the 401 was new, only one company in England offered a suitably heavy plinth (it was actually made out of slate). In most installations, the poor old 301 had to make do with plywood or worse.

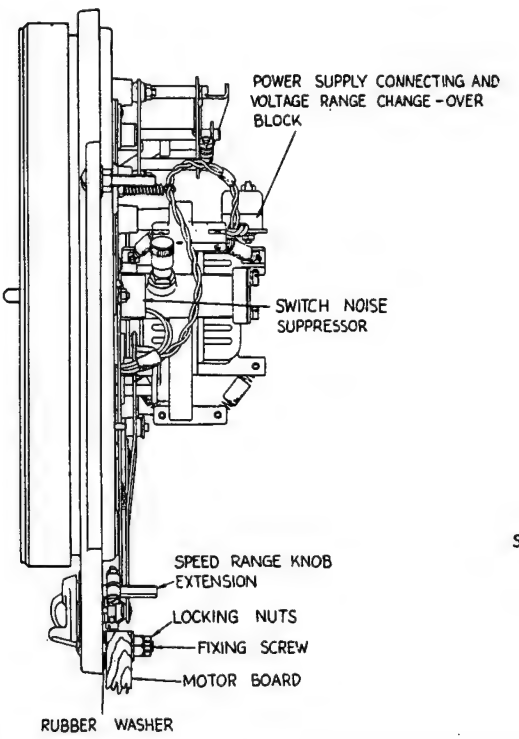
In short, the problem with the 301 was a *plinth* problem and nobody realized it at the time. The popular 'radiogram' console cabinets of the day were great resonators for the 301's vibrations. The classy hardbound Garrard instruction manual was way off track as well. The makers recommended a sprung motor board, a recipe for disaster. A popular plinth was made by S.M.E. that applied the same theory. One would have thought they knew better.

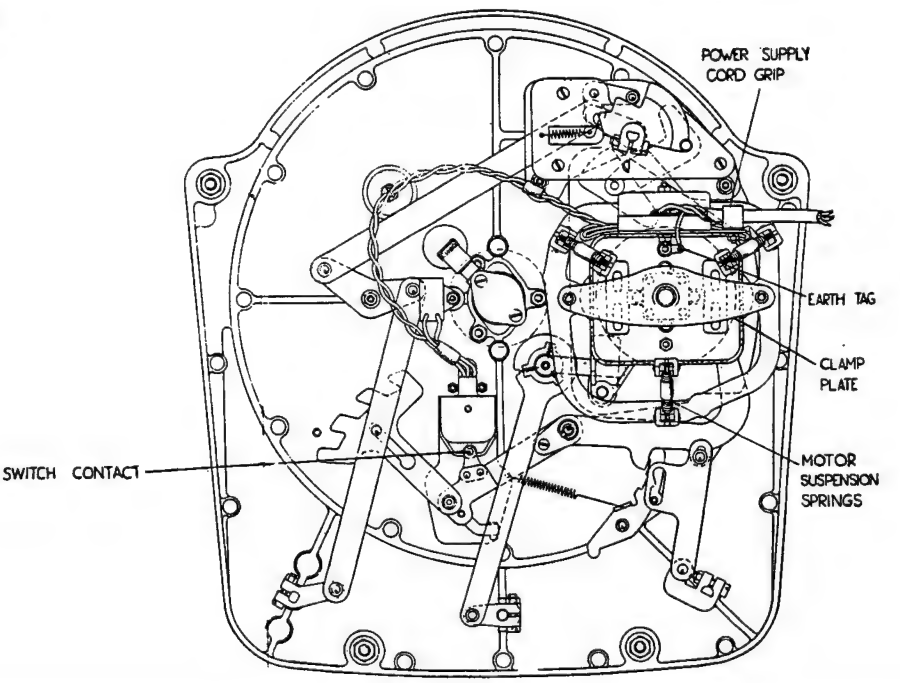
A solid, heavy plinth cures 95% of all unwanted motor noise. Half a dozen kitchen table outfits have recently popped up offering suitable items. Most of them are pretty good, if a little on the expensive side. Just remember — the more mass you provide, the more you banish noise.

Another reason these units throw out so much vibration is due to the eddy current brake system. This awful device labours the



Model 301 — Mechanical Details





huge shaded pole motor slightly, to allow adjustments in turntable speed and to adjust for slight variations in the size of the idler wheel.

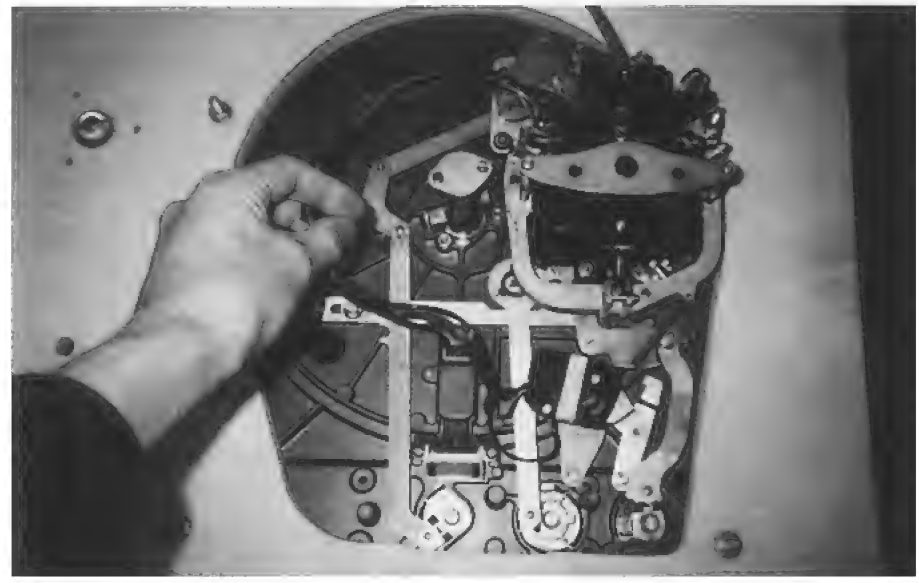
Garrard's pre war turntable, the '201' (two speed, 78 rpm and 80 rpm), was even harder on the motor. This system used a centrifugal governor working against a felt pad. It's no wonder the motors are always burnt out on pre WWII radiograms.

Anyway, back to the eddy current brake. Through a series of levers, turning the pitch control knob slides a magnet over an alloy disc fitted to the shaft of the motor. With the knob turned fully counter clockwise the magnet is positioned over the disc and slows the poor old motor down, resulting in the deck running 2 1/2% slow (just 1 1/2% for the 301). Turning the knob clockwise positions the magnet off the disc, allowing the motor to run at its normal mains electric frequency. 2 1/2% fast of course! Normal operation is with the brake half applied. And that is the problem, the brake is *always* in operation.

To make matters worse, on the last 401s the alloy disc was very badly positioned, and tended to oscillate on its axis. The nearer the magnet to the disc, the more it labours the motor and slows it down. The further away, the less the effect. Now imagine our poor motor having the above applied 50 or 60 times a second. You have to hear this to believe how bad it is.

The 301 has a slimmer disc which is easily dented in transit if someone forgets to tighten the transit clamp. On the plus side, the magnet itself is not positioned over the disc. Instead, two 'arms' are positioned on either side of the disc. These connect to the magnet and allow the eddy currents to be 'steered'. This system is an advantage over the 401 because the disc is within a field between the two arms, and thus the speed is not affected as much.

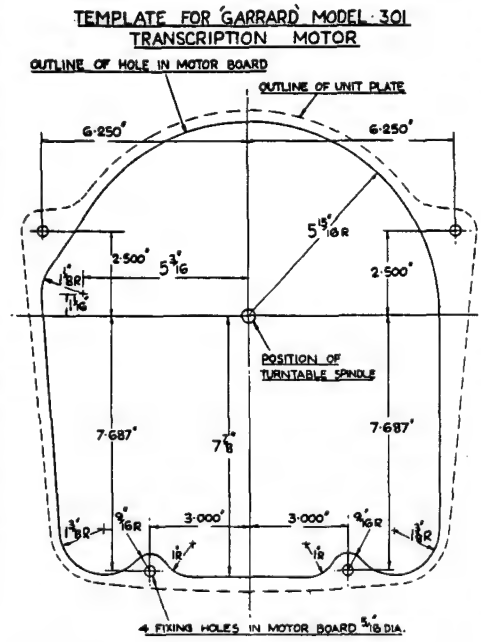
A simple tweak is to reduce the voltage to the motor — 20% is about the right reduction. There are two ways of doing this: using a transformer or by wiring a light bulb in series with the motor. On UK supplies a 40 or 60 watt light bulb gave best results. Once you have a bulb socket wired up it is easy to try different wattage bulbs. Remember the lower the wattage the higher the resistance and the less voltage the motor gets. Therefore, the less noise the brute puts out.



Loosening the wiring harness from the 401 motor can reduce rumble

A major upgrade is to remove the eddy current brake completely and fit a dedicated variable frequency power supply. The problem is that there are not too many power supplies capable of supplying an 80-90 volt sine wave variable between 45 and 60 hz at a power of over 12 watts. Reducing motor voltage means the deck takes a second or so longer to reach full speed. Big deal, in practice this is just not that serious an inconvenience.

One point to watch on all 401s is the power harness. Half a dozen wires hang out of the motor. These go to the double pole mains switch and the neon lamp at the front. Halfway along the journey to the switch, the wires are secured to the chassis by a little spring. Since this is too close to the motor, it acts as a path for the energy from the motor to travel down to shake the rest of the chassis. I usually remove the spring and simply let the wires dangle.



The main bearing has come in for a lot of hammer recently. Unless your original one is damaged, leave it alone. I have tried four different bearing mods and all of them except one produced more background noise. The other one provided a marginal improvement at first, but became noisy after a couple of weeks' use. At the moment, I am still waiting for the guy to return it to me. I think it is all a load of cobblers! The only bearing mod not tried is by a guy called Shindo. Apparently he is a major guru in the Japanese hi-fi scene. If anyone has any experience of Shindo's 301 mod, let us know the story.

Good lubrication is important. If the bearing has been neglected, then the copper sides will have worn quite badly. You can check for this by gently rocking the platter from side to side. Any play means a new bearing housing, or trying to find someone to remanufacture yours. It only takes a few minutes to remove the entire shooting match, so take it out, clean it, check for wear and then rebuild it with a good oil. If your deck is the grease bearing type, the original Garrard stuff seems about best. None of that in stock? Then fill it with Castrol CL (chassis lubrication) grease.

Remember to oil the shaft as you refit it to the housing. Oil as you go. *Never*, ever have a good grease bearing modified.

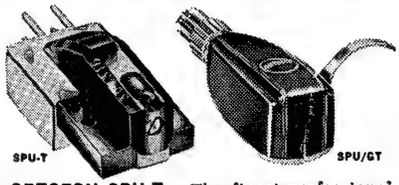
While you have the bearing apart check the thrust pad for wear. Note that someone at Garrard chose to change the shape of the thrust pad from the original flat surface to a convex shape in the 401. In my opinion, this is not quite as good as the original 301 design. It might be worth considering a modified bearing for your 401 because of this factor.

Same applies to the motor. Strip, clean and rebuild applying oil as you go. The motor runs fast and gets hot. I tried using good quality car engine oil which worked quite well. The best was a dedicated motor oil designed for VCR motors made by Hitachi. Frankly, even old 3 in 1 is better than nothing, so don't lose sleep if you cannot find anything exotic to lube your table with.

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Ortofon SPU — The world's longest lived stereo component?
(1959 Advertisement)

The poor old idler wheel tends to come in for a lot of unfair stick. Everyone blames it for producing rumble noises. Completely wrong, of course. An idler only needs replacing if it has developed a flat spot, usually the result of leaving the deck in the on position while no power is being applied. Just to prove the point, my 401 is on its original idler! A couple of drops of oil on the idler bearing helps keep it sweet.

One subtle difference between the two decks is the shape of the platter. On the 301 it is totally flat. The 401 platter was designed together with its mat to have a 'hollow' in the centre, while the edge of the mat is very slightly undersized.

Records are supposed to be 'dish' shaped. That is, the outer edge and centre are raised compared to the middle where the grooves are. This is still recommended by the E.E.C. Most modern decks have a dish shaped mat or platter. The problem is not all record manufacturers follow standard practice. If you go through your record collection it will more than likely be a fifty-fifty split.

After exhaustive listening tests and half a brewery of beer consumed, I settled for the 'flat' platter as the best option. To be truthful, mine is a little more complicated than that.

Mats serve two functions. One is to dampen out platter resonances, and to protect the record from trapped dirt. Some may argue that it serves to 'couple' the record and platter together. Personally, I think the latter is horse shit.

I tried all sorts of things to stop platter resonances. Slightly filling the underside with shellac, plaster of Paris, concrete, blu-tak, plasticine. None of them worked very well, although they did help a bit. After deciding several years ago that most mats are designed to smear dynamics and take the edge off detail, I wondered how I could do without it.

By pure accident a glass platter was popped on top of a 401's bare metal platter. Rapping them with my knuckles produced very little noise. The two materials had damped each other out. So that is what I now use. A slim glass platter on top of the original item. The glass is easy to keep clean and is flat. With warped discs a Mitchell clamp holds the ensemble together. Normally the clamp stays in its box.

All of my listening these days is with an Ortofon SPU cartridge. Without doubt one of the most underrated pieces of vintage hi fi. It deserves an article of its own. One problem with the brute is that it weighs nearly 40 grams! Only one or two arms can balance it, let alone match its compliance. Personally, I cannot manage without it. Every time I listen, it sends shivers up my spine. I have tried others, but I'm hooked. Forget drugs — score an SPU, its more mellow.

Contrary to popular belief, Ortofon still makes SPUs. At least two versions are available in the European market: Original and Gold Reference. Only the Gold Reference is imported to the UK, although I have sourced the other from Italy and Germany. This must make it the longest production run of any stereo hi fi component!

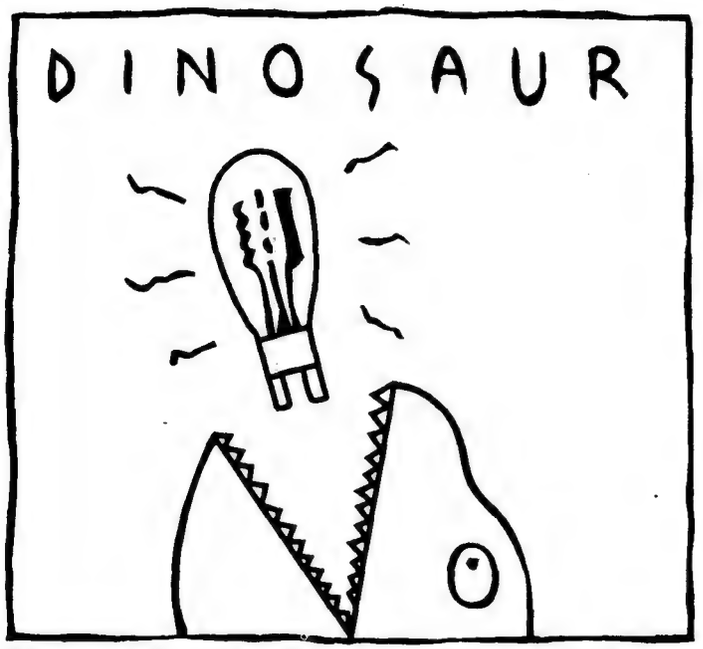
The best arm I have tried with an SPU is a Fidelity Research FR64S. Possibly the first 'tweaky' arm to use silver wire. (I would love to get hold of the 12" FR66, has anyone ever seen one?)

Arm and cartridge choice is not critical on either of the Garrards. Just make sure your arm matches your cartridge. Since they offer totally uncoloured sound and have no suspension system to upset, virtually anything goes.

When set up correctly, with a decent high mass plinth, and a good arm and cartridge, I know of no deck that conveys such speed and authority. On upbeat rock music everything is in control. Bass notes seem so much tighter than any belt-driven deck I have ever heard. With classical you appreciate the deck's totally silent background; nothing is added, and nothing taken away. Ella never sounded so good (except live at Albert Hall).

Quite a lot of manufacturers use vintage Garrards. 401 users include Glen Croft (Croft Acoustics), Ole Moller (Copland), and Yoshiaki Sugano (Koetsu). Even Tim de Paravicini of famed Esoteric Audio Research uses a 301.

With Dr. Digital now peddling even worse new medicine in the form of DCC and minidisc, you should rescue an old Garrard before it is too late. You owe it to yourself.



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Welborne Labs
P.O. Box 260198, Littleton, Co 80126
PH: 303-470-6585 Fax: 303-791-7856
Visa and Mastercard accepted

UK GARRARD RESOURCES

Martin Bastin makes the "Max Plank" plinth system. Made entirely of plywood, but weighs more than the Slate Audio marble plinth! Martin is a firm believer in the superior sonic qualities of this material. A very complicated plinth to make; all of the voids underneath the deck are filled. Must take a day to make each one.

Also supplies bearing upgrades and remachines all parts of tired Garrards other beers can't reach. A genuine good egg with a lot of his own theories and ideas. Does a good overhaul service.

Martin Bastin, 225 Tettenhall Rd., Wolverhampton, West Midlands, WV6 0DE.
Tel. 0902 751861

Loricraft Audio offers a complete service on any turntable. Makes a fairly decent plinth system and turntable power supply (well, OK, its just a transformer and a light bulb!) Has lots of nice tweaky things. Send an SAE for catalogue. Also operates a record cleaning service.

Loricraft Audio, 4 Big Lane, Goose Green, Lambourn, Berkshire.
Tel. 0488 72267

Slate Audio manufactures solid marble plinths for the 301/401 (UK cost around £350). Also sells glass platter mats.

Slate Audio, 47 Gemini Close, Leighton Buzzard, Bedfordshire, LU7 8UD.
Tel. 0525 384174

Technical and General offers genuine and replacement spares for most vintage turntables and cartridges. Services, repairs and overhauls. Has arm boards available for Thorens, etc. Prices range from expensive to just plain crazy. If you need an idler wheel or a knob they have someone remanufacturing them, not as good as the originals but better than nothing.

Technical & General, P.O. Box 53, Crowborough, East Sussex, TN6 2BY.
Tel. 0892 654534

That is about all of 'em in the UK— but no doubt someone will call and complain that I missed them off. Needless to say, anyone looking for a 301 or 401 should contact Audio Classics!

Audio Classics UK
8 Lowe Mill Lane, Hindley
Wigan, Lancashire WN2 3AF
Tel. 0942 57525, Fax 0942 525861

Meet the Tube. . .

the classic 45

Unlike the mighty 845, the type 45 doesn't draw a crowd. It doesn't glow white hot. It doesn't tower above other tubes. You don't say WOW when you see one lit up from across the room. The two watt power rating is a joke these days. In the contemporary Western audio scene, the type 45 is *not* considered a serious player. When you mention "45," what typically comes to mind is a seven inch record — not a stalwart power triode.

This is a big mistake. The 45 can produce some unbelievably natural, pure, and agile sounds. Unfortunately, speakers of adequate sensitivity to showcase the 45's talents are rare creatures, even more scarce than these antique triodes themselves.

Back when the type 45 was introduced in 1929, 2 watts was a reasonable power specification. Blew the popular 0.8 W Type 71A away for power. How loud would you want to turn up your table radio anyway? Nowadays, to opt to listen to a two watt amp is making a powerful statement. The 45 is a tube for audiophiles comfortable with their manhood. Or people with big horn speakers. In any event, despite its marginal measured output, some crazed tubeophiles swear that it is the best audio tube ever made.

Because antique radio collectors need them to keep old broadcast sets going and a strong export market in 45 tubes adds competition for this dwindling resource, the flea-power 45 commands a price equal to or above that of its twice as powerful sister, the 2A3. But included in the price is a valuable audio lesson: two watts can really play if you give it a chance. Don't think of it as two watts — think *two thousand* milliwatts!



Type 45 tubes were made for about 30 years and they came in many varieties. No two tubes in this heap are identical!



45

RCA 45

POWER AMPLIFIER

Filament	Coated			
Voltage	2.5		a-c or d-c	volts
Current	1.5			amp.
Direct Interelectrode Capacitances:				
Grid to Plate			7	μμf
Grid to Filament			6	μμf
Plate to Filament			3	μμf
Maximum Overall Length				4-11/16"
Maximum Diameter				1-13/16"
Bulb				ST-16
Base				Medium 4-Pin
Pin 1 - Filament			Pin 3 - Grid	
Pin 2 - Plate			Pin 4 - Filament ◊	
Mounting Position	BOTTOM VIEW		Vertical, Base Down	

CLASS A AMPLIFIER

Operating Conditions and Characteristics:				
Filament	2.5	2.5	2.5	a-c volts
Plate	180	250	275 max.	volts
Grid * ◊	-31.5	-50	-56	volts
Amp. Fact.	3.5	3.5	3.5	
Plate Res.	1650	1610	1700	ohms
Transcond.	2125	2175	2050	μmhos
Plate Cur.	31	36	34	ma.
Load Res.	2700	3900	4600	ohms
U.P.O.	825	1600	2000	mw.

◊ Cathode-bias is advisable in all cases; required if grid-coupling resistor (max. value 1.0 megohm) is used.

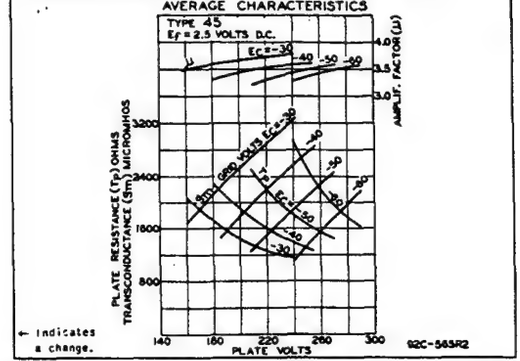
CLASS AB_2 AMPLIFIER

Values are for 2 tubes

Typical Operation:	Fixed Bias	Cathode Bias	
Filament	2.5	2.5	a-c volts
Plate	275	275	max. volts
Grid	-68	-	volts
Cathode Resistor	-	775	ohms
Average Driving Power (grid to grid)	636	460	mw.
Zero-Sig. Plate Current	28	36	ma.
Max.-Sig. Plate Current	138	90	ma.
Load Resistance (per tube)	800	1265	ohms
Effective Load Res. (plate to plate)	3200	5060	ohms
Total Harmonic Distortion	5	5	%
Power Output	18	12	watts

* Grid volts measured from mid-point of a-c operated filament.
◊ Horizontal operation permitted if plane of filament is vertical.

AVERAGE CHARACTERISTICS



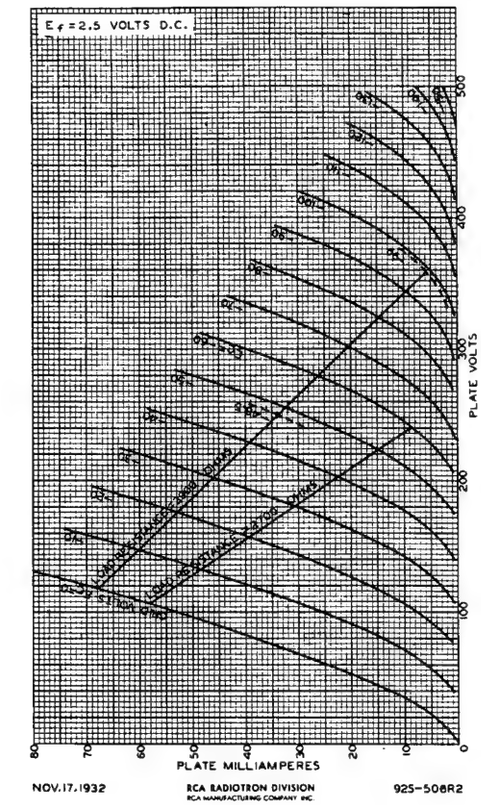
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APRIL 20, 1938 RCA RADIOTRON DIVISION RCA MANUFACTURING COMPANY INC DATA

Put those 45s to good use! Build yourself Gordon Rankin's killer two watt direct coupled current sourced 45 amp — a micropower favorite.

Credits: Wavelength Audio, Alan Douglas. Photos: Alan Douglas

45



AMALGAMATED WIRELESS VALVE CO. PTY. LTD. SYDNEY, AUSTRALIA — JULY, 1937

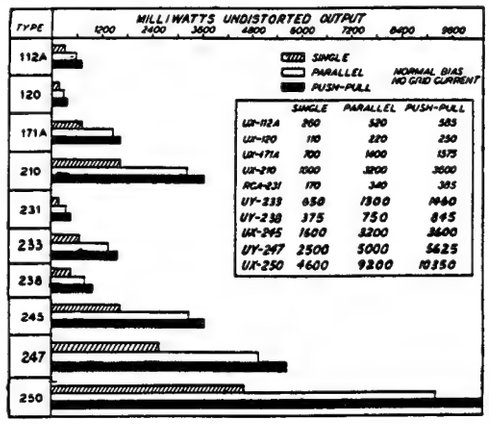
"RADIOTRON" RECEIVER TYPE TRIODE OUTPUT STAGES

VALVE	TYPE 45										TYPE 2A3					
CLASS OF OPERATION	A_1			RR A_1			RR AB_1				A_1	RR A_1	RR AB_1			
PLATE VOLTS	180	250	275	180	250	275	250	275	250	275	250	250	300°	250	300	300
DC. GRID BIAS*	31·5	50	56	31·5	50	56	55	66	55	66	45	45	*	45	62	65
KIND OF BIAS	SELF BIAS								FIXED BIAS		SELF BIAS			FIXED BIAS		BACK+ BIAS
BIAS RESISTOR OHMS	1020	1470	1550	510	735	775	810	830			750	375	780			
LOAD RES. " OHMS	2700	3900	4600	5400	7800	9200	3900	4000	3900	4000	2500	5000	5000	2000	3000	4000
ZERO SIG. I_P	31	34	38	62	68	72	81	87	38	28	60	120	80	120	80	80
MAX. SIG. I_P	*						68	82	68	82			110	185	140	115
POWER SENSITIVITY**	1·8	1·3	1·3	0·9	0·65	0·65	0·9	0·65	0·9	0·65	3·5	1·75	0·6	2·5	2·0	1·6
TOTAL HARM. DISTORTION %	5	5	5	2	1	1	2	2	2	2	3	2	5	1·5	2·5	2
DOMINANT HARMONIC	2	2	2	3	3	3	3	3	3	3	2	3	3	3	3	3
POWER OUTPUT WATTS	·825	1·6	2·0	1·65	3·2	4·0	4·85	6·0	4·85	6·0	3·5	7·0	10	10	15	13·5
MAX. GRID RESISTOR.	1·0 MEGOHM								0·1 MEGOHM		0·5 MEGOHM			·05 MEGOHM.		

* 300 VOLTS TOTAL SUPPLY † AS DESCRIBED RADIOTRONICS 78 ‡ AT MAX. SIGNAL INPUT.
** MILLIWATTS PER VOLT SQUARED (R.M.S.) # PLATE TO PLATE FOR PUSH-PULL OPERATION.

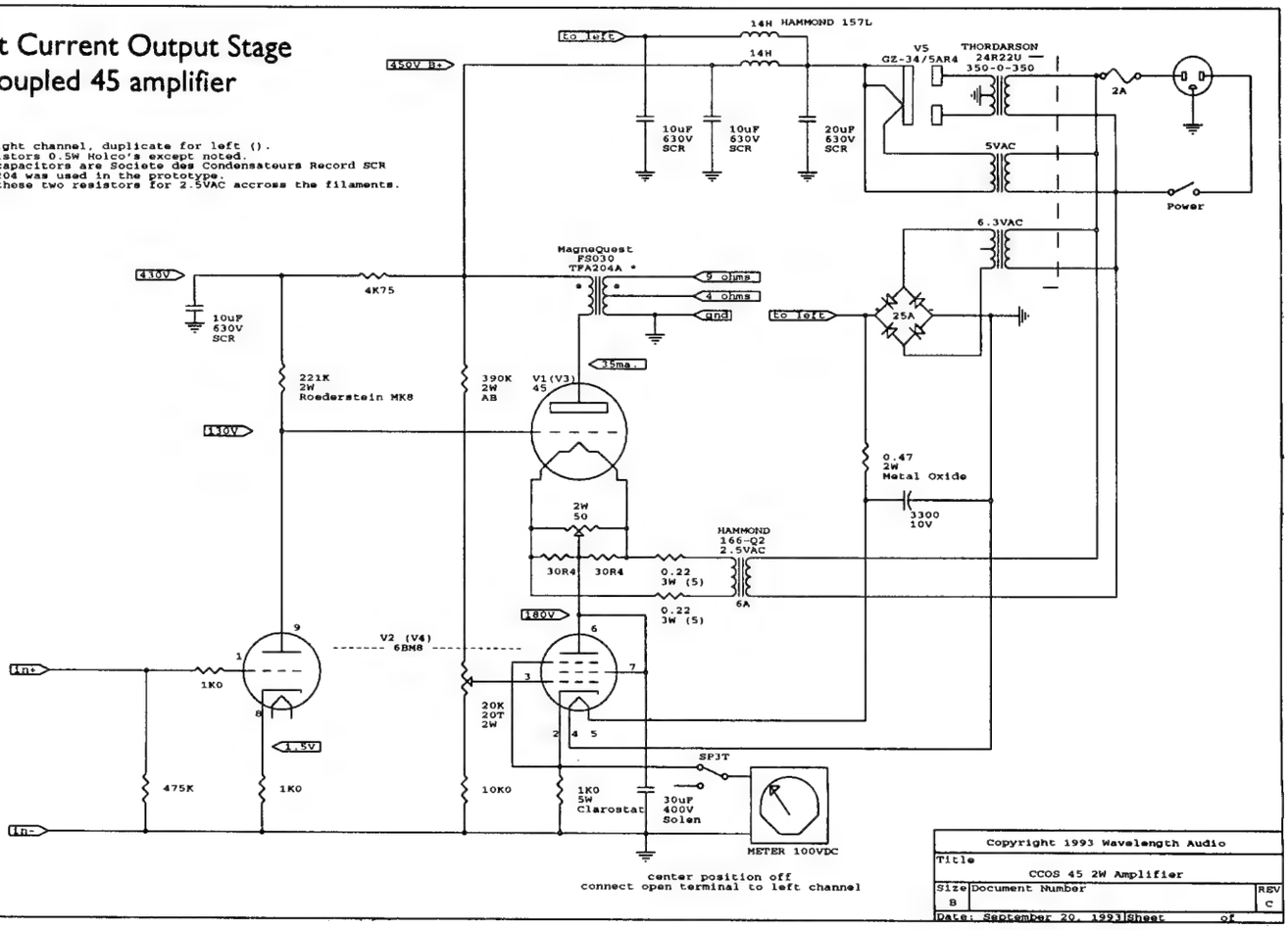
RADIOTRON
TRIODE OUTPUT STAGES

As this 1930s data suggests, a type 45 is equivalent to half of a 2A3. They didn't have 2A3s back in '29 when the 45 was introduced. The power tube competiton then was the flea power 71A (171A), the high plate impedance 10 (210) which required an expensive high voltage supply, and the type 50 (250). The 50 put out a big 4.8 watts, overkill for the typical in-home amplification task of the era — the radio played through a newfangled dynamic loudspeaker. With 2 watts out at low voltage, the 45 was well suited to early consumer electronics applications.

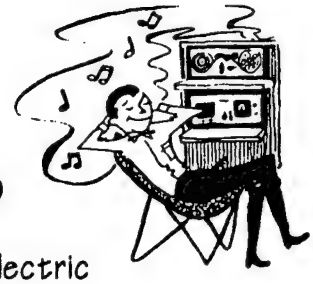


Constant Current Output Stage
Direct coupled 45 amplifier

Notes:
1) Shown right channel, duplicate for left ().
2) All resistors 0.5W Holco's except noted.
3) All HV capacitors are Societe des Condensateurs Record SCR
4) The TFA204 was used in the prototype.
5) Adjust these two resistors for 2.5VAC accross the filaments.



Casual Reactions



by Herb Reichert, Eddy Electric

CAN'T STOP RUNNING WATER:
The Edgar Horns and The Blue Island System

The horn skeptics are dropping like toddlers in a marathon. The phone lines are abuzz. The Edgar Horn System is opening musical doors and turning on perceptual lights for open-minded audiophiles across the United States and overseas. Here in NYC the High Fever boys are working their jig saws and keeping their irons ON. Based on our continuing auditions, the triode-amped Edgar horn is beginning to look like the greatest audio discovery since the LP.

I fully expect that the mainstream manufacturer/press coalition will soon discover what tens of thousands of Asian and European music lovers have known for almost two decades: that carefully engineered triode/horn systems will play the hell out of your records in a way that makes "recommended" audio systems seem sterile and emotionally distant.

We are so enthused that we have begun to collaborate on an all-out *Blue Island System* (BLue ISland System = BLISS) here in the old Staten Island Firehouse. The purpose of this system is to create triode magic that will take us to places we have never been before. Because of lower distortion and elevated dynamics, music recreated by the triode-horn combination follows a direct conduit to our nervous systems, hearts, and minds.

Triode maniacs take enormous, detailed soundstages and scary resolution for granted. This is Class A, no-negative feedback, triode turf. The real breakthrough is the EHS. Never before have the virtues of low power directly heated triode amplifiers been revealed without the serious dynamic compression of conventional cone/dome systems or the peaky resonances of theater horn systems. These wooden, cone driven horns showcase the beauty of musical presentations without asking us to overlook the ringing and serious colorations which come stock with most other horn transducers.

These observations are based on three very different systems which all have the Edgar midrange horn in common:

- A tri-amped setup with MOSFET-powered transmission line bass, a 4" throat mid-horn with a Focal 7V, and a Polydax PR-120-il tweeter.

- A system consisting of a single-ended 6B4-G PP amp, a Petit Onken bass cab, a 4" throat horn with an Altec 755C, and the glorious Onken OS-5000 tweet.

- My system, which currently employs Altec 515As in a VOT cabinet with a 1 1/4" inch stone top and no crossover and 2 1/2" throat mid horns with Dynaudio D-54 drivers in spiked, sand-filled cabinets. I use series 48 mF oil caps to cross over to the D-54 and a series 4 mF cap on the PR-120.

Any of the these systems will give you more goosebumps than ANY store bought system, but this is only the beginning. Beyond all the above lies the *Blue Island System!*

WHY BOTHER?

Before I describe the "soon to be completed" BLISS, I would like to remind our readers why I think any of this is important and why I think one should go to the considerable effort to "create" a system of this nature.

When we experience the beauty of art (painting, poetry, music, etc.), we very often consciously acknowledge our recognition of this beauty by saying something (i.e. Wow!) or doing something (i.e. pausing for further study). The simple experience of acknowledgment has great significance to our personal development. The mechanism of recognition must come from within. In other words, we must "comprehend" beauty.

Our ability to recognize or comprehend the sublime in art is probably founded in our experience of the sublime in nature of which we are an integral part. The beauty we recognize on the "outside" is DIRECTLY RELATED to the beauty we recognize on the "inside". The inner experience of beauty enhances the possibility of the outer experience and vice versa. Our efforts to seek beauty directly relate to our experience of "quality" in life. All of this is a sort of barometer of who we are now and what we aspire to be.

Man, I believe, endeavors to create and understand "sublime architectures" like those he perceives in nature. A Ferrari, the Sistine Chapel, Van Gogh's Irises, Mozart's *Don Giovanni*, the electromagnetic spectrum — these are all sublime architectures. High quality music reproduction can be a channel to an almost infinite variety of these architectures. To this end it behooves us to establish a type of audio engineering which is capable of illuminating these artistic structures in recorded music. If we can enhance our systems' "communicative skills," if we can design a system that showcases more "artistic intent," we can open doors to understanding ourselves, nature, and the hearts and minds of the composers whose music we choose to play.

We perceive the sublime in art through contrasts; big-little, hard-soft; near-far; light-dark; warm-cool, etc. You will have to trust me on this, but to my aging senses, the type of system we are undertaking here preserves the nuance and drama of these contrasts better than anything else available.

I believe that a fine music reproducing system, listened to in the privacy of our homes allows us two critical enhancements not available in commercial live-music venues. First, and most important, is the ability to choose the great performance we feel like hearing NOW! Not the second rate Beethoven we paid six months in advance for. Second, we can, dance, cry, scream, shake, or tear the roof off this place at will. Do not underestimate the power of these freedoms. I often enjoy radical changes of program too. Going from Laurie Anderson to Junior Wells, to Sun Ra, to Wagner, and

finishing with "Love in Vain" and "You can't always get what you want" might just be what I need to get my creative juices flowing. Our BLISS is intended to let us exalt in these kinds of indulgences. In this issue I would like to give you some engineering architectures to work with.

CAN'T TAME A CRAB: What to do about Crossovers

One of my biggest regrets is the amount of time I spent tweaking passive speaker crossovers. I began to spend equal amounts of time devising strategies to avoid using any crossover. Every time I successfully eliminated a choke or a cap from the amp load the music became more vivid, detailed and alive. Setting driver levels can also be a nightmare.

There is one solution which solves all your crossover problems at once. . . at the expense of a few extra amplifiers. If you want to go beyond the mundane in audio, I believe there is no easier way than to provide high quality loudspeakers with separate bandwidth-limited amplifiers for each driver. With this method, the drivers are connected directly to their own amplifier's output terminals and there are no additional parts, gain stages, or buffers.

Additionally, the amplifier can be specifically designed to meet the electrical, mechanical, and sonic needs of the driver. Going beyond simple interstage filters the drivers response can be adjusted by clever use of multiple time constants inherent in every amplifier design. Fortunately for us, the Edgar horns seem to require none of this type of skullduggery. *On to the BLISS. . .*

FINER THAN FROG'S HAIR: Speakers With Bowties

One reason horns became dinosaurs was the nastier aspect of "horn sound". Another drawback is that horns do not fit in well with most peoples' ideas of home decor. Taming horn resonances and making them "handsome" is still tricky as ever. We are trying to create a home speaker system that exceeds Wamm and has a touch of WAF. Okay I admit it: WAF is well down on the list of priorities for the BLISS. However, with the proper veneers, grill cloths, and marble colors it can be made quite attractive — see Raul Gil's setup for inspiration.

Figure #1 shows our steel spike, sand-filled horn, stone arrangement. No one will guess you have load bearing joist supports in the basement! This system is a bit heavy but it sings like Pavarotti.

BLUE ISLAND SYSTEM: Electronic Architectures

Figure #2 shows the schematic for the bass amp I have chosen to power the Altec 414s in the Petit Onken enclosures. A solid state amp could provide better bass transients and lower octave transparency but the low input impedance would require that I use an active filter with a buffered output to interface with my preamp which has a slightly high output impedance.

Fixed bias on the 2A3s would also reduce any subjective effect of softness in bass regions, but I prefer the overload characteristics of cathode bias. This 10 watt push-pull amp represents a compromise in some areas of bass performance but I think this amp will redeem itself in the smooth tonal transition at the 100 Hz turnover point.

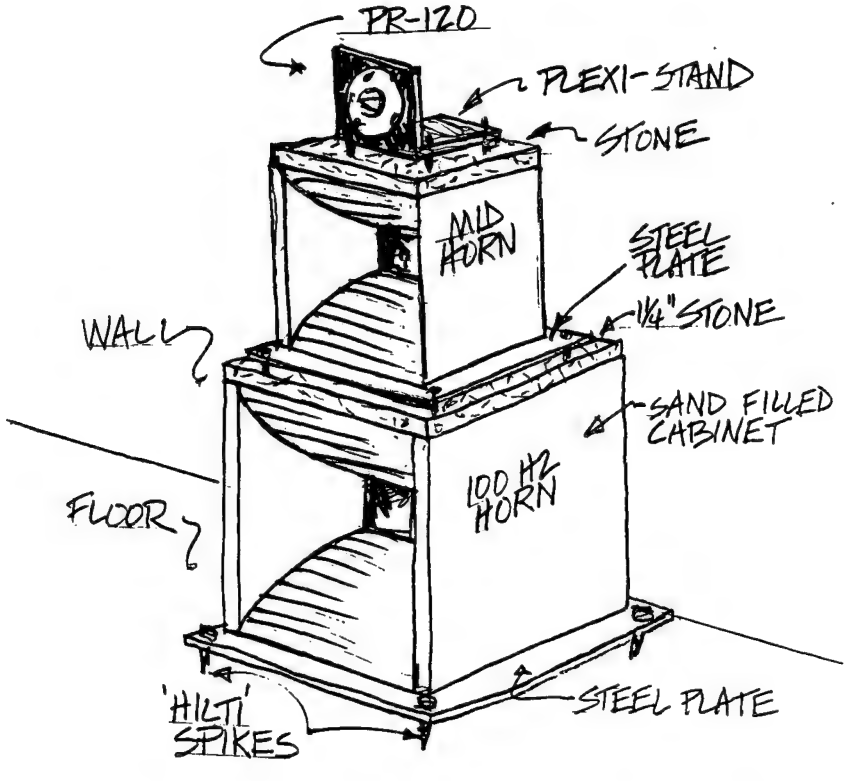


Figure 1 — Visualization of Blue Island System

Figure #3 shows my 300B Single amp with the 100 Hz-500 Hz bandpass filter installed. I really love the speed and vivid textures of the 300B single throughout the midband. This amp will power the soon to arrive Edgar 100 Hz horn. Bruce tells me his horn comes in at 110 dB/watt/meter!

The Edgar 100 Hz horns are approximately two feet on each side, designed to be used against a wall but away from the corners. The beauty here is the potential freedom from room boundary effects in a region typically sabotaged by cancellations and doubling just below middle C.

Having a dedicated amp makes bringing the level down to the 98 dB of the Onken easy and minutely adjustable. At 500 Hz, 1 dB level mismatches are certain to skew tonal balance. Precision stepped attenuators at the inputs of each amp will allow the BLISS to be tweaked to +/- 0.5 dB through the critical lower midrange.

Any amplifier with a direct coupled and a R-C coupled stage can be configured as a bandpass amp using a R-C network between the direct coupled stages for low pass and a coupling cap in the R-C stage chosen to yield the desired LF roloff point.

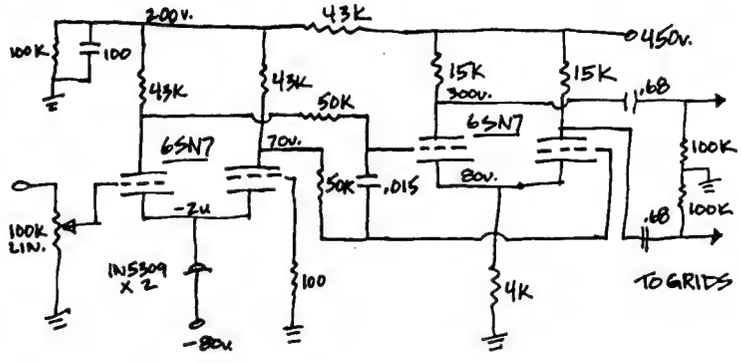


Fig. 1 - 2A3 Push-Pull Bass Amp
100 Hz low pass

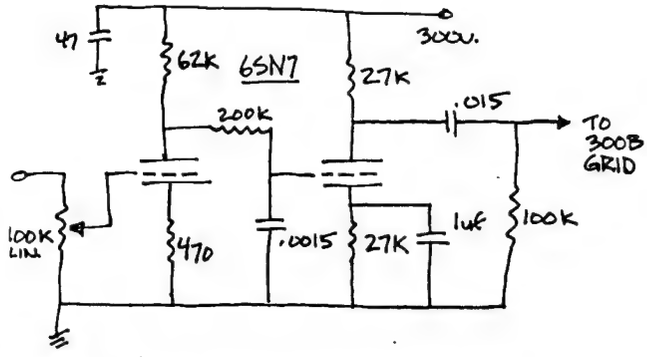


Fig. 2 - 300B Single 100 Hz Horn Amp
100 - 500 Hz Bandpass

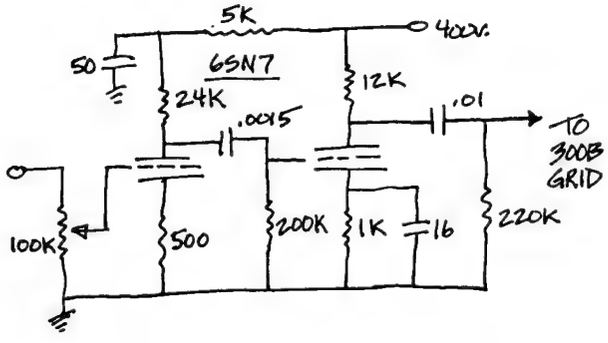


Fig. 3 - 300B Single 500 Hz
Midrange Horn Amp

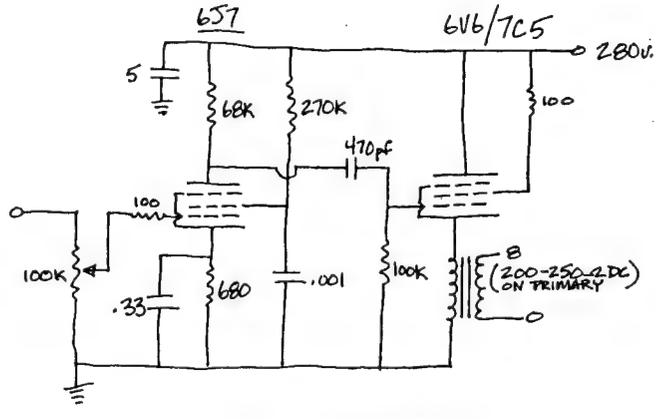
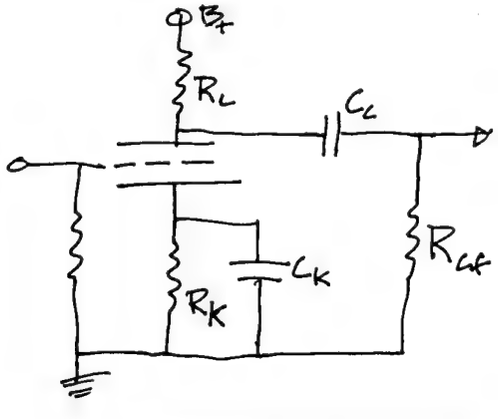


Fig. 4 - PR-120 Tweeter Amp



$$f_1 = \frac{1}{2\pi RC}$$

$$C_L = \frac{1.6 \times 10^6}{f_1 R_{cf}}$$

$$C_k = \frac{1.6 \times 10^6}{f_1 R_k}$$

f_1 = low frequency limit

Adjusting time constants for passive high-pass interstage filter networks



Reader Raul Gil and family perched on Raul's handcrafted full range Edgar horn system.

This creation is finished in rich maroon lacquer and birds-eye maple veneer, combining Deco Movie Palace style visual appeal with horn loading down to 40 Hz ! For constructional details on Edgar's *Monolith* bass horn, see *Speaker Builder, 1993:6.*

Figure #4 is the schematic for the amp I presently use with the Edgar mid-horn. It has only a 500 Hz high-pass filter. The D-54 is very well behaved outside its horn-loaded passband.

Figure #5 is a suggested schematic for a PR-120 tweeter amp. This design uses the 6J7 for low input capacitance and good RFI rejection. Tweeter resonances can have a very serious effect on midrange clarity. They can sabotage voice articulation and upper midrange tonal balance. This design uses three staggered poles to get the amp as far down by 2000 Hz as possible without severe phase shift or ringing. This is an untested design which, if implemented, should be examined on the scope looking closely for transient and phase anomalies outside the 5000-20,000 Hz passband.

BIRDS OF A FEATHER: THE PR-120

Dr. Edgar spent twelve years developing these horns and then he "casually" recommends the inexpensive Polydax PR-120 tweeter ($50) for use with them. Last issue, I was recommending the JBL 2405 as the best choice at a reasonable cost. Well, I take that back! Further listening has shown that this tweet is way out! I can't believe how good it really is. I have been listening to the new version, the PR-120i1, in the tri-amped system mentioned earlier and you can buy this unit with no reservations. Only the Sequerra Ribbon, the Plazma and the Onken OS-5000 have sounded better in my experience. Thank you, Dr. Edgar for your great taste. You can contact Bruce Edgar at POB 1515, Redondo Beach, CA 90278.

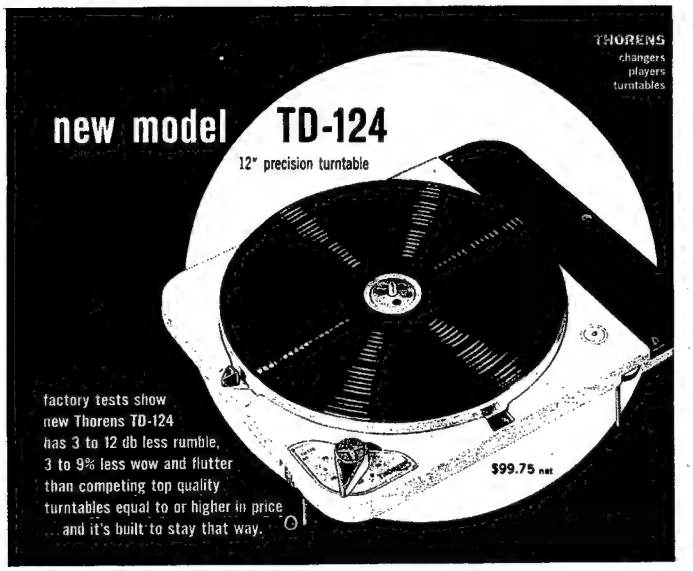
In my next installment I will go into the details of system setup, measuring, and wiring. In the spirit of shared discovery, I hope you will continue to do your own research on the edge of audio art. Remember, the High Fever boys still believe that there are AT LEAST 144 perfect ways to do anything.

THE MUSIC GOES ROUND AND COMES OUT HERE: The Thorens TD-124

Part of my "research" involves going around to NYC audio salons and harrassing the proprietors to let me "study" their systems. My purpose is to figure out "how it works". I do this to lonely audiophiles with original type systems too. The only thing I can say for sure I have learned is: when comparing the best to the best, analog front ends provide INSTANT goosebumps and visceral access to musical contrasts while digital sources seem to even everything out by generalizing on textural and coloristic details. The sensation of "something special and beautiful" or the effect of "tough and gritty", or the notion of "hard" in rock — these aspects seem to get lost in digital and show up in spades on analog. The serene, the nasty, the heroic, the hesitant, the shy, all come out very clearly in analog. These are some of the qualities we are designing the BLISS to elucidate.

I have always admired the audiophile who had the means and good taste to assemble a perfectly set up turntable/tonearm/cartridge combination. This is where the truly sophisticated music lover shows his character. He can assume the role of connoisseur and art collector by his selection, setup and maintenance of these components. This, to me, is where the "high end" was to be found. Unfortunately, entry level costs for front end connoisseurship are kinda steep for my blood. Undaunted, I have spent much of my adult life seeking high-end analog on a mid-fi budget.

After my cheapo late-70's Garrard with the free cartridge, I stepped up to a Dual 1219 with an ADC cartridge. Then came the Kenwood KD-600 which I loved for about 12 years. Then IVOR! He made me save my money for a LP-12, but when the time came to plunk down my cash, I wavered and swooned and bought an all out SOTA at the last minute.



Here's a new hi-fi turntable that works on an absolutely new principle—The Thorens "Roto-Drive," actually two turntables in one — *to give the lowest flutter, wow and rumble of any 12" turntable with equal or less moment of inertia*... Performance far exceeds broadcast standards for wow, flutter and rumble... exceeds that of turntables with hysteresis synchronous motors. What's more, the TD-124 gives you a truly outstanding combination of features. Check them!

* Continuously running, heavy 10-lb. rim-concentrated cast-iron lower table or fly wheel that—
  1. Provides high inertia (3 times as heavy as aluminum; outweighs 16" aluminum turntables).
  2. Completely shields pickup from strong hum fields.
* Light aluminum cover table with attractive mat that—
  1. Forms precision rotating surface.
  2. Allows fast starts and stops (1⅓ rev. max.)
  3. Prevents attraction of pickup magnet to flywheel.
* Exclusive Thorens clutch instantly joins heavy and light tables, makes starts fast, makes cuing easy. Saves records; you can start turntable *after* you've placed stylus.
* Four speeds 16⅔, 33⅓, 45, 78.
* Built-in illuminated strobe disc for all speeds.
* Plus or minus 3% speed adjustment for all speeds.
* Built-in turntable level for easy leveling.
* Built-in knurled leveling screws accessible from top of unit.
* Easily detached, standard 12" arm mounting board. (16" board available as accessory.) You can change arms without leaving unsightly marks.
* Shock-mounted "Roto Drive" motor is completely vibration isolated by limp, extremely compliant belt drive, plus large idler.
* Easy to mount, only 2¾" clearance required below mounting board. Top surface requires 15 ½" x 12 ½" with 12" arm mounting board; 18" x 12 ¾" with 16" board. (NOTE: These are minimum dimensions; arms with rear overhang may require slight additional space allowance.)
* Comes with power line cord, shielded pickup cable and solder plate.
* May be used on 50 or 60 cycle alternating current. 100-120, 125-150, and 200-250 volts. Easy to change over.

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THORENS

SWISS MADE PRODUCTS
NEW HYDE PARK, NEW YORK

Thorens TD-124 ad from 1959

For about a year it was my favorite possession, then I noticed that I spent most of my listening time looking for albums that "sounded good." I used to just play what I felt like listening to with no forethought about sonics.

Once I realized what I was doing, this search for sonics became even more of an obsession — one that excluded whole record labels and their artists from my listening repertoire. No more Columbia, Deutsche Gramophone, or Phillips! I knew this was bad, but I didn't know how to stop.

At first I thought the cheap MMT arm must be "dead". I bought a FT-3 looking for "life". Very little improved. So what the hell maybe it's my choice of cartridge. . . so I tried a few others. Still, the system seemed "off" and "sour" and "even". Adventure returned quickly, however, when a friend turned me on to the Thorens TD-124. We compared it to his Well-Tempered/Van Den Hul set up and it was no contest. I sold my SOTA instantly and started listening to ALL my records again.

The Thorens excelled at presenting weight, body and rhythm. These are qualities that I treasure and were lost in the SOTA and the Well-Tempered, but should I have bought a Linn in the first place? We know it is a rhythm master, but would it let me play records with no sonic forethought? Would it make me stop wondering if I was missing something? The Thorens is so old and clunky looking I always wonder if the NEW high end rigs would outclass it like the new preamps outclass the 7-C and SP-6. Then came John Atkinson and Corey Greenberg singing about the Linn and extolling the "good ol' soul" of the LP-12-Lingo-Cirkus. HOO HAW!!! MAN!!! HAHA-HAHAHA!!! MAN O MAN!!!

That was it! I begged and borrowed and got a Linn Valhalla and set it up exactly like the TD-124: identical Fletcher MDC-800 arms, identical Kimber KCAG Silver arm cables, Shure V-15-V, Adcom Crosscoil, and Stanton C-100 and 981LZS cartridges. I even made two mahogany arm boards to eliminate another variable.

Guess what? The Linn showed me why I have never heard a bad system with an LP-12 playing the records. The Linn is very, very transparent. It is transparent in a way that makes recorded performances seem extra holographic and pristine. This transparency takes over your listening space and impresses your friends. Its tempo keeping ability will also give you weeks of delight. But! But! I think the emperor is not fully dressed! Alas, he forgot his pants! The weight, body, and drive that gives a performance momentum and keeps the rhythm going is missing.

So what about the 124? It seems equal to the Linn in every area except noise floor and transparency. Plus it has a bit of "weight" that the Linn lacks. Now I was really getting frustrated. Even if I had lots of money I still didn't know what I wanted. Remember, I am a body-freak. One super rare quality that my big horn system with Thorens TD-124 has is that at very low SPLs it will still vibrate my chest and rumble my chair. Even at low levels you still can feel the bang of the kick-drum on your body! Try *that* on your system. With the Linn, most of this quality was missing. But, I love that transparency. The Thorens was thick and opaque by comparison.

This state of affairs gave me a high fever. I started changing and tinkering and trial and erroring till I made the Thorens transparent. I think I have excavated maybe 90% of the Linn's transparency out of the venerable old clunker. Try this: remove the aluminum platter cover and mat from the 124. Scrape off the rubber spacers from the platter itself. Next, replace these rubber spacers with dots of 'Blue-tac' and unfasten the three screws that hold the rubber mat on the platter cover. As you replace the cover on the platter, press firmly, making sure the cover is level and parallel to the heavy rotating platter. Add a gray felt Discwasher mat and reset your VTA and stylus pressure. That is all there is to it. All we are doing is changing the record/table interface. Isolating the platter cover reduced the noise floor and the felt mat imitates the Linn record platter interface which I maintain is a substantial part of the Linn sound.

While the LP-12 gives "high-Q" bass, the low bass performance of the TD-124 is a bit on the soft and wooly side — even after modification. Hence, the punchy bass of the Linn does not seem to be a result of the felt mat. In any case, the 124 with a felt mat seemed to subjectively lose a few Hz at the very bottom, but the leading edge of bass transients is clearly improved.

All in all, the Thorens shows itself to be a true contender for wannabe high end connoisseur types on a budget. I truly expect that with the addition of a high quality power supply and line voltage filtering this table could perform at the highest level. The 124 deserves the attention of some creative minds with musical souls.

reMUS

phono and line PREamplifier

Jan P. Lodstrom,
Stockholm, Sweden

A popular DIY preamplifier circuit from one of Sweden's leading tube freaks!

While we are waiting for a semiconductor good enough to match the sonic performance of the electron tube, I submit a tube-equipped preamplifier for your building pleasure. Because of its simplicity it is a reasonable project for the home constructor.

On the whole, this is a sensible circuit without frills or mysteries. It has been quite popular in Sweden among local do-it-yourselfers since the design was published in the Swedish magazine *Audio-Video* a few years ago. Builders are especially happy with the quality of the preamp for playing vinyl discs.

The preamp uses five tubes, each of which handles both channels. Two 12AX7s provide the phono amplification with RIAA equalization. A 12AT7 is used for an isolation stage and driver for the volume control and tape output. The line stage uses a 12AU7 as a voltage amplifier direct coupled to a 12AT7 cathode follower to provide a solid low impedance output.

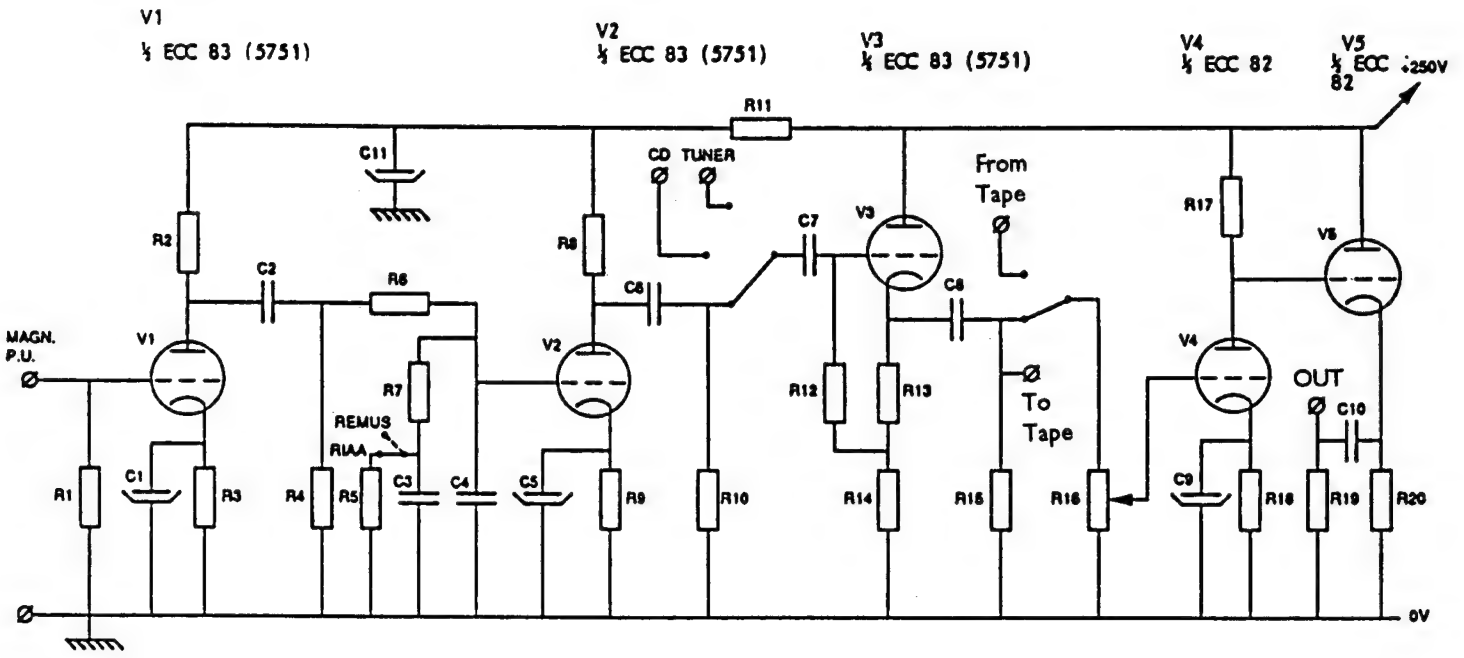
The power supply is unregulated in the "official" version but some might want to employ some form of regulation. The simplest way would be shunt regulation with voltage regulator tubes such as one each OA2 and OB2 in series across the plate supply voltage. A supply voltage of about 320V would be required to ignite the tubes. Series regulation according to standard practice would also work well. The entire preamp circuit only draws about 10mA from the B+ supply.

The heaters should be fed by a DC source to minimize the risk of hum via cathode/heater leakage, especially in the input stage. Two schemes for providing DC to the heaters are pictured below. With a 10 VAC winding, C must be 10000 mF for acceptably low ripple. If you have a 12V winding on your transformer use a CRC (pi) filter where each C can be as low as 2200 mF and R would be between 5-10 ohms, 1 W. Adjust the value of R for 12V DC.

The value of the volume control can be any value between 25 K and 250 K, preferably logarithmic taper. I consider a balance control unnecessary. It is best to remove the cause of imbalance — speaker placement, unevenness of amplification in the tubes, or whatever it might be.

The better the quality of the tubes you use, the better your preamp will work. I call it the "REMUS", by the way, for "REproduced MUSic." As eager students of the specialist magazines, you probably know that there are several improved versions of the tubes used in this circuit. The industrial grade version of the ECC81/12AT7 is the 6201 and they are usually excellent. The fancy European goodies in the 12AT7 family are the E81CC and ECC801S. The latter version is especially highly recommended. The ECC82 and ECC83 have industrial numbers E82CC and so on. The US version of high quality 12AU7s are 5814A and 6189. For 12AX7, substitute 7025 or 5751.





Component values

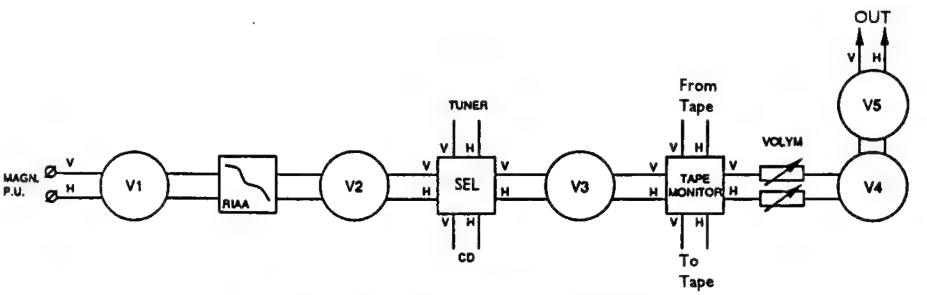
Note that only R11 and C11 are common to both channels.

R1	47 K	C1	47mF, 10V
R2	220 K	C2	0.1 mF
R3	2.2 K	C3	30 nF
R4	1 M	C4	10 nF
R5	240 K	C5	47 mF, 10V
R6	100 K	C6	33 nF
R7	10 K	C7	33 nF
R8	220 K	C8	1.5 mF, 150V
R9	2.2 K	C9	47 mF, 10V
R10	1 M	C10	3.3 mF, 150V
R11	4.7 K	C11	min 25mF, 300V
R12	470 K	* close tolerance polystyrene	
R13	560		
R14	33 K		
R15	1 M		
R16	25-250K log.taper		
R17	100 K		
R8	2.2 K		
R19	220 K		
R20	22K		

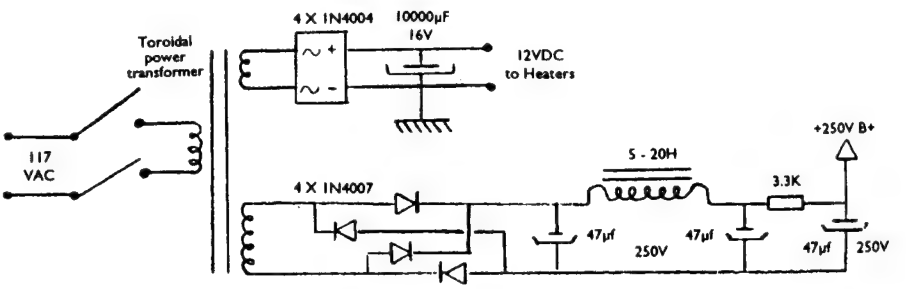
Transformer
Pri. 117V (or 220V)
Sec.1 190V 25mA
Sec.2 10V, 3A
Choke
5-20H, 10mA

The 5751 is not exactly equivalent to a 12AX7 but it is close enough and very good sounding.

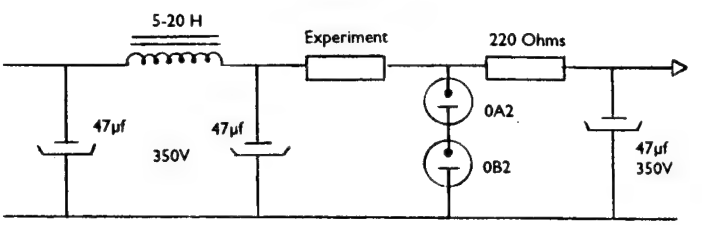
Some of you may wonder what the little switch marked REMUS-RIAA does. It is my feeling that some records benefit from a continuing rising amplitude characteristic below 40 cycles which is the normal pivot bass frequency for the RIAA curve. In the



Block Diagram of REMUS preamplifier



Power Supply



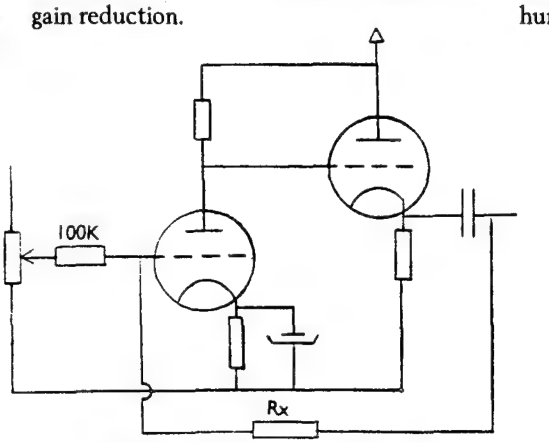
VR tube shunt regulation option

"REMUS" position, the pivot frequency is moved down to 15 c/s. In this lowest audible octave, most speaker systems have severe losses. If you have a reasonably good power amp that doesn't limit at 20 c/s, you will certainly get a boost, literally!

If you have difficulty finding a choke for the power supply, you can substitute a 470 or 500 ohm resistor for it. All resistors, except the one in the heater circuit, can be rated at one quarter watt. All non-electrolytic capacitors can be ordinary polyester or of finer quality as desired. Be sure to use polystyrene or polycarbonate capacitors of close (2% or better) tolerance in the RIAA section.

If you think the line stage is suspiciously simple, it is. Surprisingly it produces only about 0.1% THD, depending on the quality of the 12AU7. The amplification is tenfold (20 dB).

If this is too much for your needs, you might improve the situation by adding local feedback by including Rx in the line stage. Obviously, the lower the value of Rx, the lower the amplification. Typically, an amplification on the order of 4 or 5 times is what we want for line stages. Therefore, we must reduce gain by 6-8 dB. The value of Rx would be between 220-270 K. Note that a 100 K resistor is added between the wiper of the volume control and the grid of the 12AU7. Of course, noise, distortion and output impedance will be lower by an amount corresponding to the gain reduction.

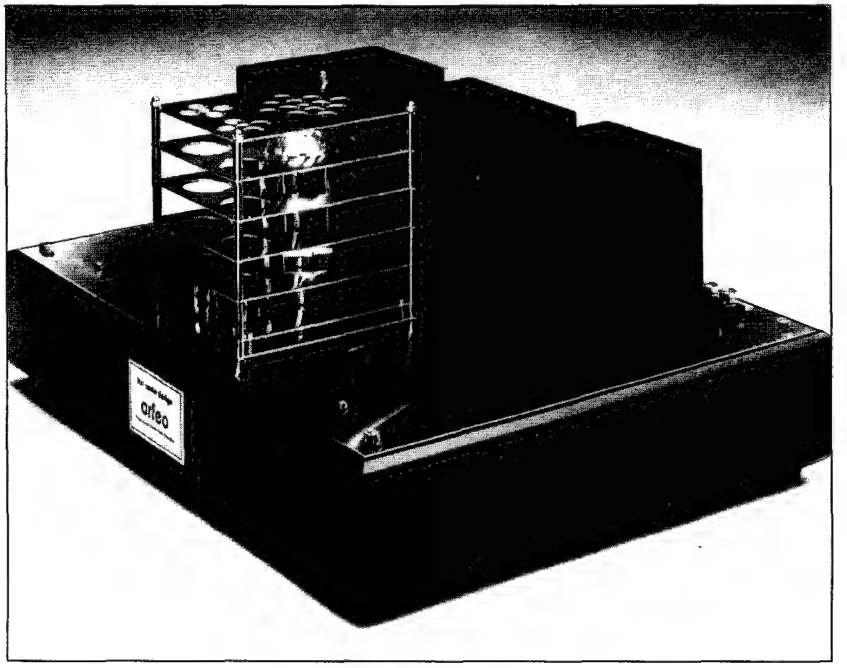


Adding feedback to reduce gain

I see that toroidal power transformers are now available in the States. Good! They are far superior to ordinary ones as far as stray magnetic fields are concerned. I can put a toroid on a chassis no longer than 10" and have no hum at all from the phono circuit at the other end of the chassis. If I can, you can too. Ordinary transformers are best located in a separate box along with all rectifiers and filter components. If only DC enters the preamplifier cabinet then how can it hum?

Build your REMUS on a metal chassis with a metal cover for proper screening. Grounding is a science all of its own. My tip; use a ground rail, about one millimeter in thickness. Connect it to the chassis *only* at the cartridge input, then connect all signal grounds to it. This is a prerequisite for hum free operation.

Hoping that I haven't come across too scientific (fat chance), I wish you all the best of luck in constructing the REMUS.



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Desperately Seeking an Efficient Speaker



by Mike LaFevre and Peter Stillwell

Now that we have these great low powered single triode amplifiers, what the heck do we do for speakers?

After *Sound Practices* #1 hit the streets, the MagneQuest hotline got lots of phone calls from people interested in using our transformers in the single ended 300B "91" circuit. Most of them wanted to know whether the relatively inefficient speakers they had would work well with this "hunk of an amplifier." Will eight watts drive my LS3-5As (or my Celestion 600s, or my JPWs, or my Vandersteens, etc.)?

The sad fact is that most of these adventurous souls have speakies that are just *terribly* inefficient by single triode standards. The majority of modern speaker systems need big horsepower to really come to life. This is not a problem if you are looking at the hundreds of medium to high powered amplifiers out there. It is only since the new wave of interest in low powered amplification arose that the scarcity of highly sensitive speakers became such a hot issue.

Although many of these inquiring souls would be pleasantly surprised at what eight watts can do, I usually recommended that they acquire a set of reasonably efficient speakers before building the fabled "91" if they want to achieve the best results. The hard part was to make an honest recommendation to them. Basically, the speaker market is way behind the times in terms of what the rapidly expanding base of triode listeners need.

Of course, I could have recommended some of the vintage drivers that were revered for overall performance capabilities and their suitability with the smaller single-ended amps and sent callers to the used market. But there were a lot more callers than there are old Altec 604s or whatever. Also, vintage speaker systems are usually anything but plug and play. You often have to build a proper cabinet to house the drivers and you may have to do some experimentation and modification to get those classics to do what you want them to do.

Many people understandably don't want to hassle with the recycled audio scene, objecting to buying raw drivers or complete speaker systems that they had never seen or heard from someone they don't know. They just want to go out and buy a new, finished pair of speakers. Nothing wrong with that.

Based on a perceived public need, I suggested to the editor that we try to assemble a small number of highly efficient speakers that are currently in production for the purposes of seeing if there is anything out there will run on, say, an amplifier with under ten watts output.

Years ago, efficient speakers ruled the roost. Amps were too low powered to allow speaker manufacturers to disregard the efficiency of their products. Then we got to the fork in the road that Herb Reichert so eloquently described in *SP#1*. The speakers shrank in size (and efficiency), and power became less and less expensive.

Then new tubes like the KT-88 and 6550 increased the power output of pentode amplifiers by 50%. The amplifier horsepower race was on and power handling displaced high sensitivity as the prime engineering challenge in loudspeaker design.

Now, we may have passed the peak of the horsepower race in amplifier design as some audiophiles are beginning to realize that less is more. Unfortunately, the result of decades of the bigger-amp-is-better mentality is that there are no contenders in the home speaker market that produce modern rivals of the beloved efficient speakers of yore: 604, 755, VOT, Paragon, Metregon, etc.

Actually, it should be possible to produce something just as efficient and much better than the aforementioned classics for audiophile applications in the average listening room. There are some very promising modern materials out there — horn tweeters and midranges with neodymium magnets, anyone? The art of speaker cabinetry has certainly come a long way since big Altec and JBL systems ruled the Earth.

I'm now a bit bemused that single-ended amplifiers are in the process of being "mainstreamed" by the high audio priests. The confessional booths at the audio temples are now jam packed. Editors and writers proclaim that they have seen the sin of their ways. Don't forget that just a fortnight ago, these same gurus held forth with utter disdain and disbelief that some kooky Japanese audiophiles might love three watt amplifiers with "antique" speakers. But the high end has gone full circle before.

In the meantime, there are a lot of disheartened ex-audiophiles out there sipping a Bud in front of their 52" color screens and groovin' to the hi-fi stereosonics of Top Gun. Who can blame them? There is no shortage of hype in this business and some of it has led in counterproductive directions.

For instance, the local tweak hi-fi industry has for decades completely ignored most of America's premier loudspeaker manufacturers. Companies like JBL, Gauss, Electro-voice, Altec, Jensen, Stephens and a few others that I've missed. All are or were manufacturers of solid, honest high grade equipment, much of which is very popular among overseas audiophiles. These companies, if they survived, flourished in markets other than hi fi, such as the pro-sound or sound-reinforcement fields. Thank God for all the gymnasiums.

There were survivors in other parts of the world: Lowther and Vitavox in England, TAD (a division of Pioneer...oops! not high end, sorry) from Japan. Additionally, there are some small companies and individuals in the U.S. and elsewhere that are committed to high-quality, high-efficiency drivers and speakers. In the U.S., Dr. Bruce Edgar is believed by many to really be at the cutting edge. Too bad he has been totally ignored by the high priests for so many years. Another fellow in Japan handbuilds really cool field coil speakers, at a reported cost of $2,500 each. This guy must be the ultimate craftsman — kudos!

Where does this leave us 40 years after the horsepower race began? Are there any speakers left in the marketplace that are efficient and worthy of consideration? To get our audition rolling, we secured four different sets of loudspeakers, all of which were appropriate for use with itsy-bitsy power amps.

The rules governing selection were simple: the speakers had to be currently manufactured in finished form (no kits this time around, folks); cost less than $2,000 a pair; and have good prospects for being favorably reviewed. It would also be a plus if two of us together could lift the speaker.

The field was narrowed from a list of 40+ speakers with efficiencies of 95 dB or higher, as identified through *Audio's* Annual Equipment Directory, to the following four products:

1 - **Audio Note AN-E:** A high-efficiency two way box speaker with an 8" paper cone woofer and a soft dome tweeter in a ported enclosure. Used by the manufacturer to demonstrate amps costing more than some small aircraft, so we figured it was worth a listen. We got the copper wired version, not the upscale silver-wired version.

2 - **pipe dream:** A Focal 7-incher in a tapered pipe enclosure, conceived by J.C. Morrison, noted Downtown guerrilla audio designer. Available from Fi in NYC as a custom-order product.

3 - **Klipsch Heresy** & 4 - **Klipsch La Scala** They might not be popular with snooty audio journalists but Klipsch never abandoned the quest for high efficiency. Let's give credit where it is due.

Our esteemed panel included a small core group of three or four people plus whoever else we could round up for a listen or two. The luminaries included my audio soulmate Jimmy Dobbs, who really hates "toy amps" and efficient speakers; Scott Stillwell, renowned speaker archeologist; his brother, Petey, who grooves on Porsches and Guzzi racing machines; Johnny Z, an accomplished luthier; Dr. Krause, a passionate audio explorer; and Jim Novak, crazed audiophile and amp builder. We were even blessed with the presence of the elusive editor of this publication at our first speaker-feast. And speaking of feasts, many thanks to Scott and Rosemary for the refreshments and warm environs in which to do our work.

We thought it was important to include a few highly experienced audiophiles with little or no direct experience of low-powered amps for balance and a touch of objectivity.

This "audition" was not set up as an official quasi-scientific review. We didn't even have a control system. Instead, we listened to a wide range of amplifiers and preamps always trying to keep things equal. For instance, when we played Mark Lyons' homespun 300B single ended, we made sure that we played it on all the speakers. What we were after was not an absolutely definitive in-depth analysis complete with a listing of all the sources and associated equipment employed. Rather, we wanted to gather impressions about the speakers that we might be able to pass on to the reader interested in the general issue of low-power applications. For additional insight, participants were encouraged to take a pair of speakers home with them to audition more carefully with equipment they knew well.

Klipsch La Scala

So let's let the cat out of the bag. After our first "group" meeting, I asked everyone which of the speakers they enjoyed the most. Which would you like to take home with you? The unanimous favorite was the Klipsch *La Scala.*

Frankly, we were all surprised. We too had fallen victim to the folklore and false stereotyping that the big Klipsches would suffer from driver-to-driver discontinuity and "horniness" (also referred to as "honkiness"). After nearly seven hours of auditions on the first day, the *La Scalas* were everyone's first choice. And each time — every time — after that, at all our meetings, no matter the size, no matter who participated, the consensus remained: the *La Scalas* brought home the gold.

The *La Scalas* played with a sense of ease, composure, and grandeur that had two local *TAS*-subscribing audiophile club members picking their jaws up from the floor. Just put Mercury's CD of "Also Sprach Zarathustra" on the smallest amp in the house (in this case, a two-watt, type 45, direct-coupled single ended designed and built by Gordon Rankin) and help your dearest friends through their ecstatic recovery. The *La Scalas* played this demanding piece with the utmost grace, control, and verve. Ever hear a two watter slam on a *La Scala?*

I'm sure you're all thinking that Mikey has finally gone off the deep end, so this would be a good time to call on another member of our elite group of auditioners to report our findings.

Again, we can't claim that these are scientific results derived under perfectly controlled circumstances. But they are accurate, at least to our ears. With that behind us, let me pass the gauntlet to Peter Stillwell, who was organized enough to take notes while the rest of us were busy munching on snacks and catching smokes out on the patio...

Listing at almost $2,000 a pair, the Klipsch *La Scalas* are the most expensive, beefiest (at 123 lbs. apiece) and efficient (at 104 dB) entries in our survey. Excellently finished in black, the *LS* are reasonably grand in physical proportions, measuring 35½"H X 23¾"W X 24½"D.

A three-way, horn-loaded system, the *La Scala* employs a 15" woofer and mid and high horns with all wiring easily accessed via the open crossover. The cabinet is somewhat resonant due to the large surface, despite overall high build quality with most joints being glued and screwed. They are highly placement-sensitive. We settled on placing them as "near cornerhorns", which gave "rock-solid imaging anywhere in the room" and softened a slight forwardness in the horns.

Everyone agreed that the *La Scalas* sound "large, open and effortless" and deliver a "movie theater-like recreation." Detailing and imaging are, with proper placement, extremely accurate, making the *LS* evocative of actually "being there". We had some concerns about time alignment of the tweeter and potential megaphonesque "horn honkiness" which turned out to be totally unfounded.



La Scala!

The *La Scala* worked with a variety of material, ranging from Bach to rock. The bass response is the only area of some controversy. Scott thought that the bass was open, akin to an Altec VOT sound, whereas John Z and Jimmy Dobbs preferred the more controlled, "tighter" bass of the Heresy. This likely stems from the larger, more resonant cabinet of the big Klipsch. Scott opined that, of all the speakers, "The big Klipsch are the most livable." Mike said, "These *La Scalas* free you from the power monkey. You could take a walkman with fresh batteries and run 'em!" These speakers allow you to pick an amplifier based on its inherent sonic beauty, without regard for power specifications.

Klipsch Heresy

Klipsch *Heresy*, at a retail of $800 the pair, give the most bang for your buck. They are 96 dB efficient. "Not efficient enough for the pee-wee single ended amps, you really need 100 plus dB efficiency for the two- to five-watt amps," according to Mike. But there's plenty of oomph on the 300B based amps for all but the most cavernous listening rooms. The *Heresy* drivers, 12" woofer, mid and high horns, are packed tightly into attractive, oak-finished cabinets with wedge shaped stands. The factory stands are inadequate and, based on our experiments, not high enough. The horns really need to be at ear level. Placed about two feet from each wall in a corner on tall spiked stands, they provide detailed and room-filling sound.

John Z preferred the *Heresy:* "Bass response is more slamming, the detail on the upper end is good, maybe even better than the *La Scala.*" We agreed that they didn't sound as open, refined, or airy as the *La Scala*, but opinions varied regarding the top end. I found the Heresy to be a little too hot, "in my face" and a little ragged in the midrange. Damping the horns might have a civilizing effect but we didn't want to go wild with loaned speakers.

These same "rough" qualities, however, made them the best rock 'n' roll speakers of the bunch. For example, they seemed totally "at home" on well-produced Clapton material. Indeed, the *Heresies* are very involving. Like dating a very sexy, aggressive and cerebral college woman: exciting, but in need of a little maturational claying and crossover work.

Audio Note

The Audio Note *AN-E*, built in Great Britain, list for $1,500 per pair and are 93 dB efficient. They are "traditional" in appearance with oak finish and black grill cloth. A nice, simple two-way speaker, the *AN* crossover is very good. The smoothness of transition from the 1" dome tweeter to the 8" woofer is impressive. One listener noted that "you pick up some notes throughout the range that are represented more truly" than with the horns. The bass is rich but undifferentiated, lacking distinct reproduction of various notes on some jazz material.

Imaging and detailing are accurate and natural sounding, but the *AN-E* sound stage, although deep, lacks the big presentation of the *La Scala.* This "smooth, creamy, nice" sound would doubtless appeal to many but left our panel of inebriated hedonists feeling "emotionally uninvolved."

We found the *AN-E* to be very sensitive to placement relative to the floor and walls and somewhat picky about amps and cables. We also found that the *AN-E* worked much better with an eight watt 300B SE than with the flea-power single 45 amp. Overall, it is a speaker that will benefit from the kind of careful system matching and setup that we were unable to furnish in the context of our auditioning session.

The *AN-E* provides a quietly satisfying, natural, and cerebral sound one can live with. But in the end, it's the sort of sound that leaves you longing for a weekend tryst with the brazen *Heresy.*

Morrison Pipe Dream

The *pipe dream* is a tapered pipe using a single Focal 7V313 per side. J.C. designed these as *midrange* speakers to be used from 100 Hz to 10 KHz in conjunction with a woofer and tweeter. A number of independent-minded listeners have taken to listening to them as stand-alone full range transducers. Don Garber at *Fi* loves them and he uses them as stand-alones in his home system with a 2A3 SE amp. A few of our contacts in the NY area recommended them highly so we got a pair in for the listening session.

The *pipe dream* resides in 7"W X 12"D X 44"H cabinets superbly crafted in relatively thin Baltic birch plywood. The speaker is mounted at the top of the tower-like cabinet, giving the whole assembly a high center of gravity. A "zobel network" tames the powerful 7" Focal driver — probably the most expensive raw driver tested here. They are visually engaging and cost $1,200 a pair.

These single-driver speakers are descended from a proud tradition: many purists single cone full range speakers such as Lowther, Hartley, and WE 755. Comparisons with the legendary WE 755 are expected, but both drivers suffer many of the same flaws. That doesn't mean that they are unlovable, just that it takes someone special to overlook the lack of top and bottom end in full range service in appreciation of other satisfying sonic qualities.

In fairness, it should be mentioned that neither the Audio Notes nor the *pipe dream* are the kind of speakers that will wow a roomful of well-fed audiophiles after they have been blasting Klipsch *La Scalas* for a couple of hours. The *pipe dream* is a subtle, intimate kind of speaker that excels in smoothness, coherence, and other "low profile" performance criteria. This is true also of the *AN-E.* They are both competent at what they set out to do, but they ain't horns and they don't have the kind of "slam and dazzle" that goes over big for a crowd of rowdy audiophiles primed to rock and roll.

Conclusion

Our little band of speaker reviewers listened intently to four pairs of loudspeakers during several sessions over several months' time. In the end and with this parting breath, I turn to my philosophical training. Want to call this a speaker review? Sure, go ahead. But we don't pretend to dictate purchasing policy here.

The best speaker to use with your single ended? We're still looking. Keep your ears open and your preconceived notions (probably acquired in hand-me-down fashion) under tight rein.

Could there be other modern-day treasures out there? Of course, two great classics are still available. First there are the famous Klipschorns at about $4,000 a pair. A quick thought experiment: how much higher in price would the Klipschorns be if they were made by some yuppie-driven "high-end" company? If you like them, get them while they're still available at this great price. And don't forget that Altec still offers the VOT in assembled form for a mere $4,300. Audition these: the new 515s are reputed to be better than their vintage counterparts by many. Don't get sucked into the religion of pure nostalgia practiced by some antiqueophiles. Use your ears and your own aesthetic judgment and share your thoughts, impressions, and findings with us through *Sound Practices.*

Some 40 years ago, Paul Klipsch argued that what the world needed was a good five-watt amp. Nowadays, my sense is that what the world needs are more great speakers to choose from optimized for the current generation of single ended amps. In the meantime, we advise you to test drive some high-efficiency speakers for yourself.

Editor's note: "Mike, this article makes it sound like you think the *La Scala*s are the best speakers in the world."

"Well, they're way better than we thought they would be and it could be one of the best $2000 speakers in the world — for single-endeds, anyway. If some yuppie high end company was making these they would cost $10,000 a pair."

Mike, ever the man of the people, owner of a two watt single 45 amp, adopted a pair of *La Scalas* for his home system. He reports good results with unauthorized tweaks like plasticlay damping on the midrange and tweeter horns and removing the protective circuitry, no longer needed with his three watt amplifier. Mike heard that a major improvement can be had by locating the crossover in an outboard box and filling the cavity holding the midrange and tweeter with sand. He thinks the Klipsch has great untapped tweak potential.

Although the *La Scala* did sound surprisingly good, part of that may have been the weight of old stereotypes falling. Even a horn lover like me didn't expect a middle of the line *Klipsch* to sound so convincing. As for their performance, with solid state gear or anything besides small triode amps, who knows? Maybe there are good sonic reasons after all as to why Klipsch speakers fell from grace sometime back in the Seventies. A pair of *La Scalas* on a GAS Son Of Ampzilla *might* provide the most painful experience you ever had.

Aside from the fact that the most popular speaker in this modest survey was a decades old design that is wrongly maligned by audiophile snobs, what struck me most about this project is how few contenders there are out there. I'd like to see a dozen competitors for the *La Scala* in terms of price *and* performance.

I can't understand why ambitious speaker designers aren't rushing to market with new and exciting high-efficiency designs. After all, business in triode amps is reported to be quite healthy and the resulting unmet demand for efficient speakers holds great opportunities for fast-moving, forward thinking loudspeaker manufacturers. Even in the experimenter underground, where manufacturing economics and practicality aren't the main drivers, progress in speakers lags developments in electronics by a large margin. Let's get on the stick and come up with some speakers!

Manufacturers' Comments

pipe dream

Fairly accurate review. I never did care much for Canal Street boom and sizzle anyway. However, I did get an irate late-night call from a usually friendly neighbor not long ago threatening to call the police. Bach organ music — it's not called the *pipe dream* for nothing — powered by the above mentioned 2A3. There are a couple of changes from the review model though. The Zobel filter is out. And there's considerably less stuffing — just enough to contain the back wave bounce. I was thinking to myself that that it was sounding a bit proper with the mods and then a certain party dubbed them the "Christian Temperance Monitors." Now they're back to their original state. George Jones sounds like there's sour mash in his veins and the opening shots of Beethoven's 7th are right there in my living room.

Don Garber, *Fi*

Klipsch

Over the better part of the last two decades, I've had the opportunity to listen to a multitude of hi fi systems, a lot of them using Klipsch loudspeakers, including my own. People are funny about Klipsch. It seems everyone has strong opinions about Klipsch. Why is this?

Over the years, I've developed some highly unscientific but usually repeatable conclusions about who likes Klipsch and who doesn't. If we rank people from 1 through 10 based on their knowledge, love, and interest in music and hi fi equipment, Klipsch does very vell with the ones through sevens, poorly with the eights and nines, and then great with the tens. Let me explain.

Ones through Sevens: These are the folks who are not highly schooled in the art and science of audio equipment. They might be normal people who only listen to AM radio in the car or they might be world class musicians. All they know is what they hear and Klipsch sounds good to them. They are not educated in the black arts of hi fi. They don't know the jargon associated with our stuff and they neither know nor care what soundstaging, depth of image, detail, or the big A, Accuracy, are. They just know that a guitar sounds like a guitar, or a piano sounds like a piano. It just simply sounds right.

Eights and Nines: These guys (I'm not being sexist, most of the eights and nines *are* males) are the troublemakers for Klipsch. We should all remember the fable of the Emperor's New Clothes. This is the one where the head guy was sold a bill of goods by his tailor, who led the Emperor to believe that he had those really hip new set of "threads," when in reality he was sportin' nothin but his own base level equipment. It took a purely honest voice (a child) to point out the truth and the Emperor became the laughing stock of the Empire.

This fable reminds me of this group of hi fi devotees that I refer to as "audio lemmings." They know just enough to be dangerous. Most of them read the audio periodicals, some of them work at audio stores. The trouble happens when they begin to read (and believe) advertising or, even worse yet, reviews of products. They go on to discuss the merits of particular products among themselves, often hever having heard the product in question. This hearsay evidence has killed many fine audio products in our lifetimes. Klipsch is often a victim of these sometimes accidentally ruthless characters.

Tens: Once again, Klipsch falls back in favor with these folks, who tend to be truly educated individuals. Engineers, designers, and others with a true appreciation and often passion for the concepts encoded in Klipsch design philosophy. They may or may not personally like the sound put forth by a Klipsch speaker (which doesn't really matter, by the way) but they respect the product for attempting to attain a stated reputable design goal, based on and designed to work within the laws of physics.

In summary, my opinion on evaluating speaker systems or any other component is very simple: *Listen to it*, preferably in your system, in your listening room. a.) If it sounds good to YOU, that means it is good for you and your system. It means nothing else; b.) If it does not sound good to YOU, don't put it in your system. It means nothing else.

This may seem overly simple and maybe it is, but I think this attitude toward "evaluating" audio components is much more sound than investing in a piece of equipment based on someone else's ears, system, room, and subjective opinions.

Mike Dyer,
Klipsch and Associates

Audio Note
Thank you for this interesting listening survey. I am pleased to note that your listeners found that the *AN-E* had a very "true" sound within certain ranges. The main design goal of the *AN-E* was to provide a quality high efficiency speaker at a reasonable price. It is our experience that they certainly do benefit from careful system matching and setup, but this is true of many, perhaps most, loudspeakers.

I am not surprised that your panel found the horns more *impressive*. A good horn system can give any dynamic speaker a difficult mark to beat in certain areas. What is needed here is a discussion of technology, manufacturing economics, and current trends in the loudspeaker market. I feel that we are at a crossroads right now with many interesting prospects for the future. I propose to write an essay of several thousand words on the subject. Is there time and space?

Peter Qvortrup
Audio Note,UK

ed.— Whoa! I know this is your favorite topic but the essay will have to wait for #6. Anyway, we're just getting started with this discussion.

Contemporary Pro Horn Systems — interesting, huh?

One theme which frequently emerges in discussions of high efficiency speakers is professional audio. Back when relatively small amps were the way it was in hi-fi, there was considerable overlap between the professional market and the top end of home audio loudspeaker markets. The same JBL, EV, and Altec components used in furniture cabinets were installed in utility cabinets for commercial installations. A good speaker back then was a good speaker — for home, theater, *or* gymnasium use.

Somewhere along the line, audiophiles and audiophile loudspeaker manufacturers decided that they were doing something different from, loftier than, and totally incompatible with the pro sound market. Pros think audiophile gear is wimpy while many audiophiles consider pro gear to be durable but unrefined. In some cases, these assertions are true but solid build, reliability, and the "professional" label do not necessarily exclude audiophile-grade performance.

COMMUNITY LEVIATHAN II



Imagine. . . an enormous listening room with a built in loading dock. . . a trailer backs up and a union crew offloads the amazing *Leviathan II* from Community Light and Sound, Inc. WOW! A pair of these six-foot square triaxes powered by a couple pairs of nice 300B amps, wouldn't that be special? At 108 dB 1m/1W, low power is not an issue!

The low end of this modest horn system consists of six 15-inch low frequency drivers coupled to a colossal sandwich-core fiberglass horn. The mouth of the LF horn is 72" by 72" with a flare rate of 32 Hz. A Community M4 driver works into a PC1452M horn between 250-1200 Hz and a pair of Community's newly developed MH 2.8 carbon fiber diaphragm HF drivers coupled to a PC464 horn handle the top end.

Overall, the unit measures 84" deep. The sensitivity of the system is 108 dB 1W/1M and it is rated for a maximum continuous level of 136 dB! Power handling capability is 1200 W continuous/ 2400 W program, so you won't blow them out with your 300B amps. Price TBA, but figure on spending all of the change you saved up for that Wilson WATT/Puppy system!

Sure, a lot of pro electronics is deservedly suspect from the viewpoint of the kind of listener who would have a small tube amp in the rack. However, many serious audiophiles in the US and abroad use pro loudspeakers in their home systems. You just wouldn't know about it from reading *Stereophile*. In Japan and Europe, quality pro speakers from makers like TAD, Gauss, Vitavox and, yes, Altec and JBL, are highly popular among top audiomaniacs. One reason you don't see more is that this stuff ain't cheap. You could get a very decent pair of small speakers for the price of a pair of TAD tweeters. Even for upper rank audiophile speakers, the costs of using some of the better pro parts would be prohibitive.

With the current resurgence of interest in horn loudspeakers for home use maybe it would be worthwhile to raid the contemporary professional market for good parts, useful insights, and inspiration. Let's look beyond the old classics like the Altec VOTs (which are far from perfect for hi-fi in stock configuration) and discover what progress has been made in pro speakers over the last few decades. No doubt there are some very worthy contenders out there among high end 'working' speakers. Here are a few to ponder.

EASTERN ACOUSTICS WORKS CF-350



This classic three way horn system is still available on special order from Eastern Acoustics Works in Framingham, MA. It uses a 15" cone in a wooden bent bass horn, a cone-driven mid horn outfitted with a phase plug from 350-3500 Hz, and a N481 1" compression driver tweeter on a constant horizontal horn. Sensitivity is rated at the promising figure of 105 dB/ 1W@1m and it is capable of 130 dB max output. Measuring a manageable 22.5 W X 48.5 H X 23.75 D, the CF-350 will easily fit in the space vacated by your IRS V.

Our pro sound guru says "Very natural mids, sweet extended highs, and tight moderately extended bass. Worth checking out." Costs less than a pair of B&W 801s or current production Quad ESLs with the advantage that you can rent them out for weekend sound reinforcement jobs!

SINGLE-ENDED AMPLIFIERS, FEEDBACK AND HORNS: SOME HISTORY

by Dr. Tom Hodgson

I was intrigued by the article on the WE 300B single-ended (SE) amplifier in *SP* #1. Your list of pros and cons for SE versus push-pull (PP) led me to reconsider why SE might be better, particularly with regard to the operation of the output tube into the output transformer (OT) and the value of the resulting voltage distortion. This is worst at low frequencies where the OT primary inductance is usually lowest.

I am a committed tube "freak", never having found musical satisfaction from transistors, for reasons as yet unexplained. My gut feeling on SE, at first, was that a SE output tube and OT ought to be more linear than a PP design. Since the OT carries DC current in the SE case, the silicon-iron core must be air-gapped to prevent saturation. Typical measured BH curves with sinusoidal voltage drive for a) an ungapped and b) an air-gapped OT are shown in Fig. 1a, b.

Note that the magnetization force H axis is ten times bigger for the ungapped case. Modern OT iron saturates at a flux density B of order 18 kilogauss, so if the tube DC current "biases" the iron to 8-10 kilogauss and the music signal swings +/- 3 kilogauss, then it is obvious that the SE design must be more linear, all very simple! Now OT design and the physics of magnetization are not for the faint-hearted. That which follows is by no means an OT design thesis. But I needed further insight into my simple view of SE.

Having grown up in England through WWII and the ensuing golden era of British tube design and recording practices, I turned to searching the pages of the *Wireless World* magazine starting with the year 1920 onwards. It was, at first, a weekly publication. I was an avid reader from WWII on, when it became a monthly periodical. A bonus of such a search was that I might perhaps trace the history of SE and PP and the ensuing use of negative feedback with chronological correctness.

The first constructional article for a quality 4W PP amplifier using a pair of PX4 triodes appeared in the May 11, 1934 issue authored by W. I. Cocking, subtitled "Constructing Distortionless Equipment". The PX4 was a Marconi triode of 2.5W output in SE class A and cost $4 (which was about one-third of the then weekly working wage). The more powerful DA60 12W triode cost $20. I was quite surprised by this article since during the 'thirties the *Wireless World* mainly covered SE radio-receiver output stages and a few transformer winding articles with no mention of air-gaps, although M. G. Scroggie of Mullard gave a graphical method for choke design in the June 1, 1932 issue based on the 1927 Hanna method. However, I discovered the mother lode in the June 22 and 29, July 6 and 13, 1939 issues, namely the article "Distortion in Transformer Cores" by Dr. N. Partridge. This article and his more academic 1942 version in the British Inst. of Radio Engineers are both referenced in the *Radiotron Designer's Handbook, 4th ed.* I learned that Partridge's work appears in most subsequent transformer texts, for example, Sturley's *Radio Receiver Design*, Vol. II (the only text I know that actually designs an SE OT) and the modern day Grossners' *Transformers for Electronic Circuits*. The latter should be easily accessible.

Partridge used both theoretical and experimental analyses to calculate transformer distortion. The output tube may be viewed as an AC voltage source, E, with source resistance Rp driving current, I, into the primary inductance, Lp. (The winding resistance R_{DC} could be included in series with Rp). The loaded transformer would have a load R_0 reflected into the primary circuit from the secondary, see fig. 2.

Before one can easily see why this circuit can produce voltage distortion it is necessary to view the BH loop in more detail. When a sinusoidal voltage is applied to a silicon-iron OT core the resulting hysteresis loop is as in fig. 3.

The sinusoidal distortionless voltage source E drives the current through the source resistance Rp into the impedance Z of the primary inductance Lp. The flux Φ = (flux density B) x (core area A), and B is determined from the BH curve for a given magnetizing force $H = 0.4\pi NI/l$, where N is the number of primary turns and l is the length of the iron magnetic path. It is crucial to think in terms of H or the amp turns NI first rather than B. The unloaded secondary voltage is proportional to the time rate of change of the flux, Φ. Note, however, that $B = \Phi/A$ is a very nonlinear function of H. The core saturates at a value designated B_{max} and also there are two values of B for a

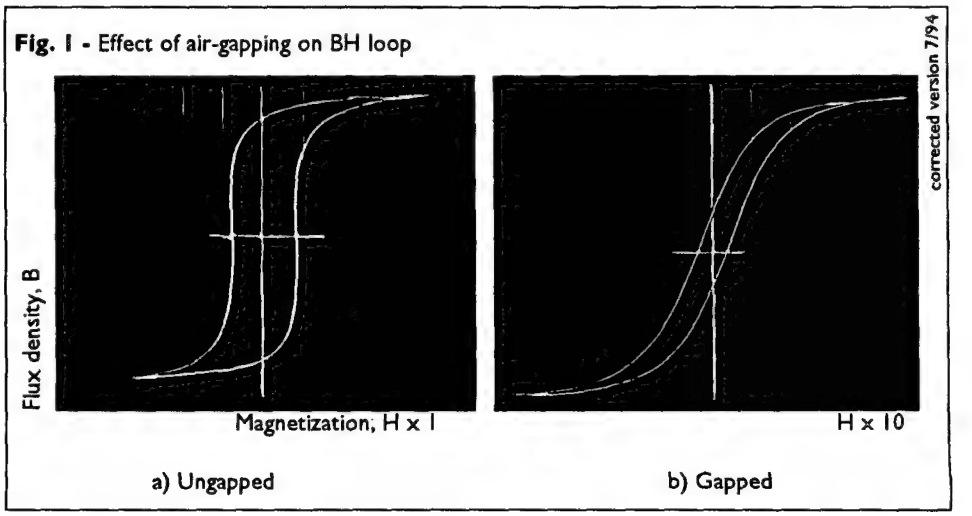


Fig. 1 - Effect of air-gapping on BH loop

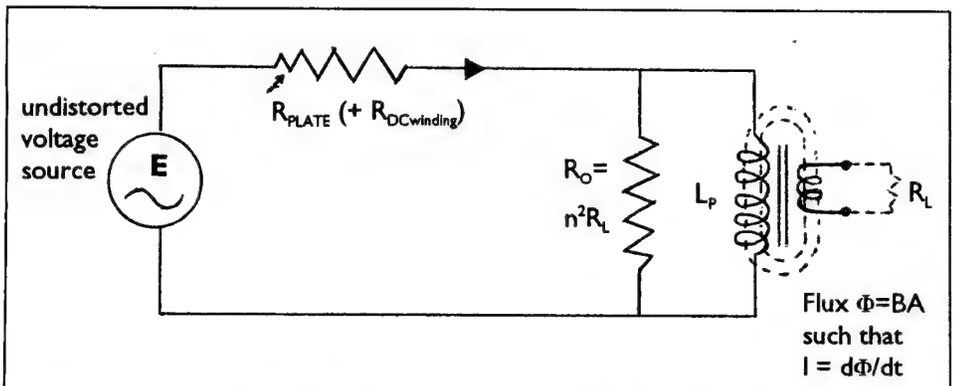


Fig. 2 — Simplified model of output transformer, referred to the primary as analysed by Partridge. Note that L depends on E, and I, and H, and B, and thus μ !

given current I or H, depending on whether the sine wave is increasing or decreasing. If there is a small sinusoidal ripple in the positive peak, say, of the sine-wave it will produce a so-called minor loop in the BH curve, see again fig. 3.

How, historically, have scientists coped with this very difficult problem of determining B? Even the great acoustician Lord Rayleigh in 1886 looked at this problem. He approximated the loop by the dotted curve, using two back-to-back parabolae. More simply, if the dotted curve is assumed to be a straight line through the origin, we have the so-called quasi-linear magnetics. The relation between B and H is written B = μH, with μ called the permeability of the OT iron. For the quasi-linear case it is constant, being the slope B/H of the line (until saturation). Actually, as fig. 3 shows, it depends on I, and H, and B.

Like most transformer texts, I have delayed giving a formula for the inductance Lp. It can be written $L = 0.4\pi NI = 0.4\pi N^2A\mu/l \times 10^8$ (cgs units), but note that the difficulty of the non-linearity is disguised. What is the value of μ for the iron, and so the value of Lp? In the absence of DC current, μ might be 2000 as compared with μ = 1 for air. This explains why the BH curve tilts over to the right so much in fig. 1b, its slope μ = B/H is relatively smaller. The magnetic "resistance" or reluctance to flux crossing the air gap is high, so that the magnetizing force or (DC) current must be higher to drive the flux across the gap.

With the above background one can now understand Partridge's elegant description of OT distortion. The driving current, I, produces a flux Φ, and hence a voltage across the primary inductance Lp (and secondary) which varies with I (or H), with μ also varying. So I is distorted, B is distorted as well as the output secondary voltage, and the voltage across Rp will be distorted by an amount opposite in sign to that across Lp (remember the voltage source is taken as distortionless). Because the BH curve is symmetrical about the H axis, the harmonics (h) will be odd multiples of the fundamental source frequency (f). Partridge measured these distortion current ratios I_h/I_f and called them the current distortion factor pertinent to the particular iron used, in his case 3½% Silicon-Iron, and varying with B, or I, or H. He plotted it against B_{peak}, see fig. 4. He called this "intrinsic" distortion because it depended on the OT, its iron, and B.

He also showed that these measurements would also closely describe the loaded OT if the secondary load resistance is reflected into the primary circuit multiplied by the turns ratio squared = R_0, see fig. 2. The distorted resistive part of the voltage distortion now appears across Rp and R_0 in parallel, = R'.

His final result is that: % harmonic voltage distortion = $\left(\frac{Ih}{If}\right).\left(\frac{R'}{Xp}\right)$ where Xp is the impedance of the primary inductance at the fundamental frequency f (=2πfLp). Partridge expanded on this formula in his 1942 papers, but my simpler interpretation follows his 1939 articles.

Let's take a simple PP example similar to one taken by Partridge to demonstrate this result. Say a 2 x KT66 pentode stage is

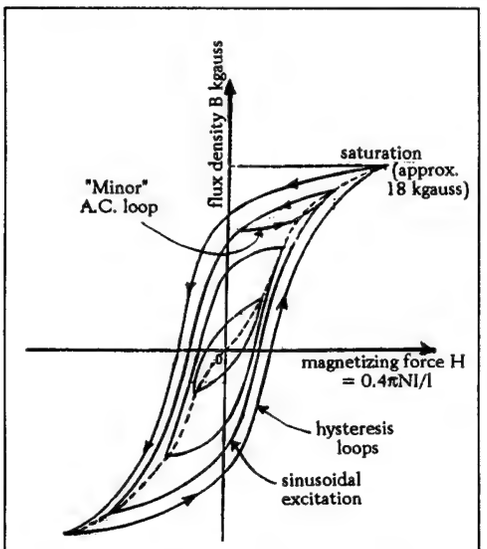


Fig.3 — The BH curve for OT iron

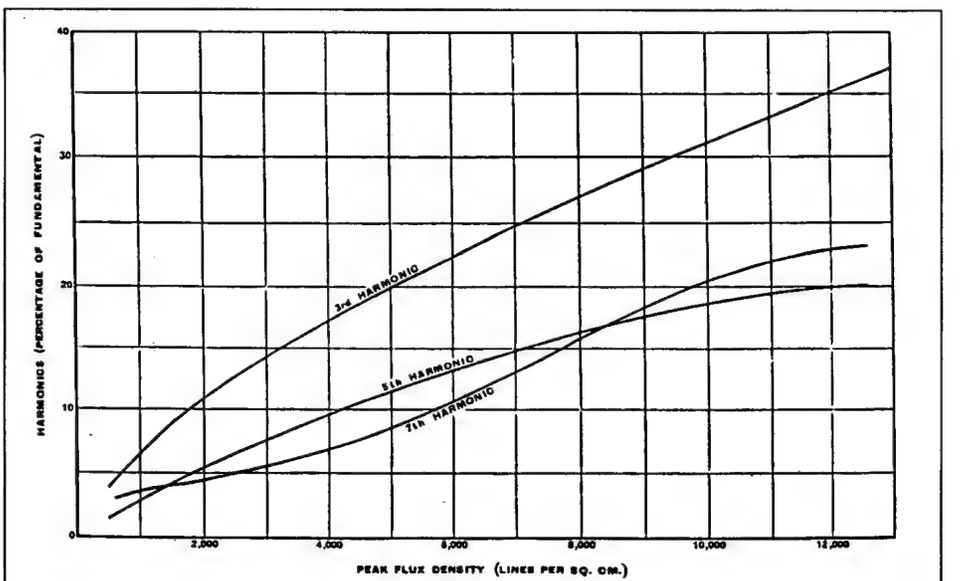


Fig. 4 — Current distortion as measured by Partridge for 3½% Silicon-Iron, 50 Hz

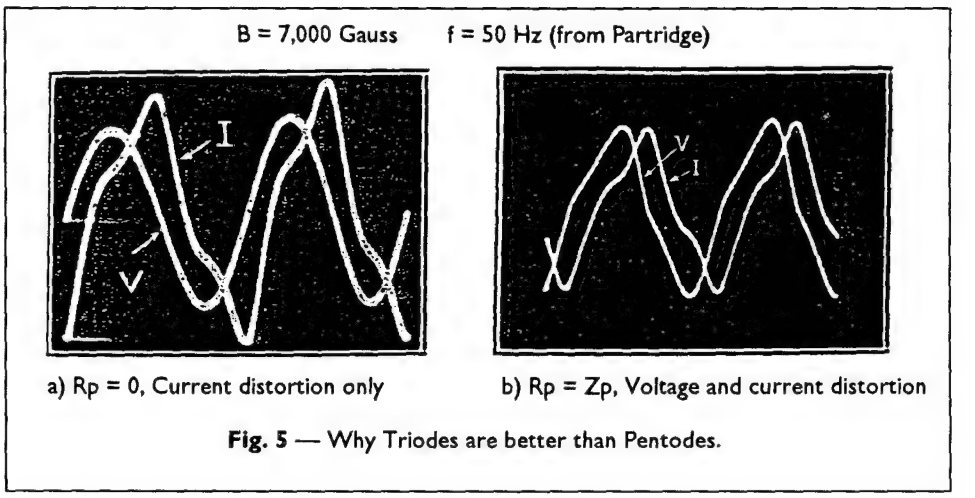
used, with 2Rp = 50k ohms and plate to plate load resistance of 5k ohms. If B_{peak} = 3000 lines/cm^2 (gauss) at full output and the impedance of the primary OT inductance is 20k ohms at f = 50Hz, then from fig. 4 the third harmonic current distortion is 14%, giving a voltage distortion = (14%) x $\frac{5kohms}{20kohms}$ = 3.5% in the absence of feedback. The advantage of triodes over pentodes is immediately seen from Partridge's equations. Say one used WE 300Bs and also the same OT is used (an oversimplified approach). A WE 300B has Rp = 700 ohms, so voltage distortion is (14%) x $\frac{2x700}{20kohms}$ = 1% ! in the absence of feedback. This, I feel, is a most revealing calculation in favor of triode output stages.

Partridge demonstrated this point elegantly with experimental measurements. If Rp = 0 there is no voltage distortion, see fig. 5a ! A typical current and distorted voltage for Rp $\neq$ 0 is shown in fig. 5b.

To me, the interesting part of Partridge's work now appeared in his fourth weekly article. He advocated the use of large air-gaps in OTs for PP designs (I calculated some 5 mils, besides the usual 1-2 mils inherently present in EI laminated cores). Now this is precisely the procedure for coping with the skewed BH loop resulting from the DC current present and loss of primary inductance in the SE case, read on.

Now what does an air-gap, size a, do? A simple view is to think in terms of H or amp-turns/inch. Then the total magnetizing force or amp-turns to maintain the flux is H_{total} (l + a) = H_{iron} l + H_{air}a, where H_{air} = numerical value of B since μ = 1 for air. The iron is still working at the same condition as before, so the distorted current I_h is the same. But now H_{total}, and so I_f is much larger, say 4 to 5 times. So the current distortion I_h/I_f has dropped by this factor. But, regrettably, as the BH curve has tilted, see fig. 1b, so has the effective permeability (known as the AC incremental permeability $\Delta \mu$) dropped by the same amount. So the value of $2\pi fLp$ = Zp has dropped by this same amount also, as has R_0/Xp! So the voltage distortion is the same!! I call this fact that Partridge pursued air gaps, even though he knew that voltage distortion does not change with air gapping, the Partridge Paradox, and is the reason why I wrote this note.

Partridge saw this result as no great disaster, believing it was better to know you had an "intrinsically" more linear OT. Now one adjusted R_0/Xp, accordingly, presumably choosing triode output tubes as well as winding big OTs within the restraints of HF response. (Remember that at that time 15 KHz was regarded as adequate for musical reproduction and I detect from certain *SP* articles that some still believe this to be the case!) So his final PP OT was wound with far more primary inductance than necessary for good LF response before gapping.



a) Rp = 0, Current distortion only

b) Rp = Zp, Voltage and current distortion

Fig. 5 — Why Triodes are better than Pentodes.

The same is true of course for the SE OT with unbalanced DC present. Thus, *for a given OT*, SE operation does not straightforwardly reduce the voltage distortion. There is an additional complication in that the BH loop is now a minor loop (like in fig. 3) around the DC bias point, which is taken around a flux density on the order of 8 to 10 kilogauss. The slope of the minor loop is the average incremental permeability $\Delta \mu$) and depends on the air gap. So there is an optimum air gap size for maximum primary inductance.

In summary, Partridge suggested keeping the current distortion factor low, then design a good output tube-transformer combination, preferably from a big OT. Now, I know this will prove controversial to some. That's why OT design is an art, better left to professionals. (This is a plug for Mike LaFevre of MagneQuest who has patiently listened to my theories of the history of OT development.) In case Partridge's result may appear to you to be quite obvious, be careful how you might use a toroidal OT with a strip-wound core, for instance. The BH curve would now be very steep sided like the loop for the ungapped case in fig. 1a. Unless the DC current is carefully balanced in a PP stage with a typical toroidal OT, the BH curve will be skewed and *asymmetrical* about the H axis. This results in large (30-40%) second harmonic distortion at bass frequencies, producing a dark and murky bass sound with a dulled treble.

A fitting conclusion for me in trying to trace Partridge's work would have been to have had the opportunity to discuss it with Dr. Partridge himself. I must thank Dr. G. A. V. Sowter (now 93 years old and a colleague of Dr. Partridge) for giving me the sad news that Dr. Partridge was the victim of a WWII V1 rocket bomb in 1944. But his conception of the output tube-OT relationship leads me to make a remark on negative feedback (NFB) and its place in Tube-OT history.

For tube power amplifiers, the publication of the four-stage PP triode Williamson amplifier by Williamson in the April 1947 *Wireless World* proclaimed the use of NFB as a means to reduce the 3rd harmonic distortion from the OT, the triodes' second harmonic being canceled as a result of the PP design. The advantages of tetrodes over triodes (from a power point of view) quickly followed in Baxendall's Jan. 1948 *Wireless World* article. But to quote, "to reduce non-linearity distortion to a given level, it is of course necessary to apply considerably more NFB with tetrodes and pentodes than with triodes" — 3rd harmonic problems again, now from the pentodes as well as the OT.

Now could this be the plus for SE designs? Is it the 2nd harmonic (in small quantities) from the class A operated triode and the DC biased OT that enhances the musical sound? The golden era produced articles on 2nd harmonic distortion and the modern disaster of slew-rate limiting was also mentioned.

I have always viewed NFB, in its usual electronics application, as a way of making a circuit more independent of its active components. The op amp plus two external resistors with high open-loop gain (ßA) such that the closed loop gain is the ratio of the two resistors is an example, with its corresponding large decrease in the output driving resistance.

One theme came across to me in reading well over two hundred articles from the golden era, namely the relative economies of the designs. Box speakers with low efficiency required higher power (pentode) amplifiers. But just looking at OT advertisements in the 1954 *Wireless World*, I came across excellent C-core OTs by the Gardner, Gilson, Parmeko, Partridge, and Sowter companies, typically costing $18 to $20 each. Harold Leak's TL12 12W KT-66 PP mono amplifier and preamplifier cost $120 at the time. I know of only one British amplifier which used a C-core OT and that was the Lowther, costing $130 per monoblock — the stereo LP was yet to arrive. The C-core is, I feel, a partial answer to the Partridge Paradox and the use of big OTs. Economics didn't permit big, air-gapped OTs for commercially produced amplifiers, but I see no reason why hobbyists today shouldn't use superior OT design.

One cannot discuss low power amplifiers like SE without mentioning horn loudspeakers. They are not only very efficient, but their inherent acoustical loading at bass frequencies help zero feedback SE design where its output driving resistance is likely to be high compared with the golden era NFB PP designs.

Following comments in *SP#4*, I too have always enjoyed my Klipsch corner horns and I have admired Paul Klipsch for the way in which he produced a relatively smooth midrange horn by experimental determination of the termination conditions at the horn mouth. This is a difficult problem for horn theory. As an acoustician myself, I can say it is not easy to solve the acoustic wave equation for sound radiation for spherical waves, say with termination in another coordinate system, like rectangular. Classical horn theory carefully avoids this problem. It can be done today on high-speed digital computers (see one suggested method by E. Geddes, *Journal of the AES*, July/Aug. 1987). It is still better, with simple designs, to resort to experiment. I came across a great construction article for a short midrange horn for a 6" diameter driver in the June 1939 *Wireless World*, correctly designed by choosing the exit area first. Edgar has championed the use of the short midrange horn with non-compression, larger than usual, drivers. I am looking forward to listening to a pair of this type of horn with a pair of original Lowther PM6 drivers shortly.

To conclude, what have I (re)discovered? The golden era people certainly knew what they were doing as regards musical reproduction, and I haven't even mentioned the two hundred or so U.S. articles I have collected. I have listened to the Model 91-style 300B circuit presented in *SP #1*, as well as a parallel 300B SE design and a 845 SE design. It is said the wavefront seems to reach one more coherently, some say the silence is darker or the low level resolution is better. I still think the Leak TL12 PP KT66 triode-connected 12W monoblocks are difficult to beat but, as yet, I have not been in a position to do direct comparisons. Now if I could only find a cure for that CD treble!

I am open to correspondence and suggestions on the reasons for the musical sound of single-ended triodes (as are the pages of this magazine—*ed.*) Dialogue on the subject is sorely needed. I hope I have pointed you in the right direction with the preceding discussion, but before you question my humble description of Partridge's work, try to read him first.

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SINGLE-ENDED CIRCUITS:
EL84/6V6, 20W, 2K6, 4/8 , 100mA PSE, $120.
300B/2A3, 25W, 2K5, 4/8/16, 90mA SE, $140.
EL34/KT88, 30W, 1K5, 4/8, 180mA PSE, $135.
EL34/KT88, 20W, 3K, 4/8, 130mA SE, $145.
6L6G, 30W, 3K, 4/8, 140mA PSE, $150.
KT66/5881/807, 30W, 3K, 4/8, 140mA PSE, $150.
211/845, 50W, 10K, 4/8, 150mA SE, $225.
300B/2A3, 50W, 1K25, 4/8, 180mA PSE, $235.
845, 50W, 2K5, 4/8, 180mA PSE, $265.
211, 75W, 5K, 4/8, 240mA PSE, $290.

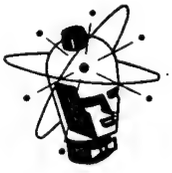
PUSH-PULL CIRCUITS:
EL84/6V6 PP, 15W, 8K, 4/8, $60.
EL34/6L6/KT66/5881 PP, 25W, 6K, 4/8, $65.
300B/2A3/6B4G PP, 30W, 5K, 4/8, $100.
KT88/6550 PP, 50W, 6K6, 4/8, $95.
KT88/6550/EL34 PP-UL, 60W, 4K3, 4/8/16, $100!
KT88/6550/EL34 PPP-UL, 100W, 2K2, 4/8/16, $200.
EL34/KT66/5881 PPP, 50W, 3K, 4/8, $110.
845 PP, 50W, 6K8, 4/8, $215.

POWER TRANSFORMERS:
D.I.Y. ONGAKU, $175.
STEREO SE 300B AMP, $150.



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PP=PUSH-PULL, PPP=PARALLEL PUSH-PULL,
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W.A.F.

by Joyce

THE ART OF THE DEAL

When friends call they often ask, "So what kind of system are you listening to these days?" Recently I've been a little hesitant to answer. I wonder, shall I make them terribly envious as I describe the wonderful system we had last week, or must I stick with the facts as they stand? "A boom box," I end up answering honestly, because the truth is that we are currently listening to a $69 Hitachi boom box. Invariably, our friends respond in shock, "But I thought you guys had a world-class system." That's right, I'm thinking, world-class system, which means that right now our system is all over the world. "Our system," I explain, "is currently in transit."

Audio equipment, I've discovered, is always in transit. Even when it's sitting solidly, right there in your living room, seemingly immobile on its sharp little tippy-toes, it's actually already on its way somewhere else. It doesn't matter if it's perfectly matched to your system, or if you've been listening to it for years. Whether it's solid state or vacuum tube, single-ended or push-pull, the one thing all audio has in common is that it's *on the move*.

It took me a while to catch on, but now that I'm aware of it, a lot of audio behavior makes more sense than it ever did before. Realizing that, for the rest of your married life, your audio system will be in a constant state of flux is an important step in understanding your audiophile mate, and the hobby in general. (It may also explain why I can never seem to get a hang of our system, but you've already heard *that* story).

Before living with an audiophile, I naively thought that audio equipment was principally intended for listening to music. I now know that there are plenty of other fun things one can do with it. Chief among these is setting up a Complicated Audio Deal. Take a good look at your husband the next time he's in front of the stereo. It may seem like he's innocently listening to music as he happily taps his fingers on the couch, but believe me, what he's really doing is mentally working out the details of the intricate audio deal he's just thought up.

All you can do is watch and wait. Is he about to sell the turntable or is it the speakers that are going? Did he get your favorite amp tied up in another impossible trade or is he just about to lend the tuner to someone in Massachusetts?

If your goal is to get rid of a particular component in your current audio system, all you really have to do is wait. (Complain a little, too, it helps speed what is a natural process). Remember, whatever it is may be here disgracing your living room right now, but it's *just in transit*. Seek comfort in the fact that before too long, at least temporarily, someone else's wife will be stuck with it.

If, on the other hand, you should for any reason wish to hold on to a component, I can tell you now, you're going to have to fight for its life. We have this REL Precedent FM tuner that I've grown very fond of. It's a cool piece of equipment, the kind guys just have to look at once and they're already thinking up a way to make a deal for it. I've had to rescue it several times from the "greatest audio trade ever." My husband's friends don't understand, "Is it because the REL looks so cool with the rest of your system, or is it because of that super smooth tuning knob, or is it ..." "Because," I mutter, so low they can't hear me, "I know how to use it and it hasn't electrocuted me yet."

Since change is such an integral part of the audio hobby, it's often only when our system essentially consists of 300 yards of speaker cable and a tuner that I realize something is wrong. I sometimes think the audio deals my man works out are so complicated, so full of logistical intricacies and nuances, that not even he can fully comprehend them. This, I suspect, is how we wound up listening to a boom box. "How can it be, " I ask, "that we have all this great equipment and yet we rarely have a complete system to play?"

Let's see, if I can remember this correctly: our favorite amps are currently "out on loan" to a friend. We have his amps, which need to be fixed, and when his amps get fixed, we can get our amps back. The way I interpret all this is, our amps aren't really out on loan, they are being *held hostage*. Try explaining it like this to a guy and he'll look at you like you're crazy. "They're *on loan*," he'll insist. Mind you, this has been going on for two years now — I know I'll never see those amps again.

Since audiophiles are usually eager to lend each other stuff, your understanding of their ways can be often put to good use. For instance, we all know that true audiomaniacs cannot resist the urge to improve on or "tweak" equipment, whether it belongs to them or not. So the next time your husband builds a truly awful amp, encourage him to lend it to the most out-of-control modifier you know. He'll either break it beyond repair or tweak it up until it sounds so good he'll never part with it, either way it's out of your life for good.

The rest of our system is being "traded" or "upgraded," which are both euphemisms for "gone". For many audiophiles, trading is a compulsive behavior and cannot be helped. It is also highly contagious, which is why the average audio trade eventually winds up involving at least four or five people in a frenzy of exchange. I don't pretend to understand the laws of this wild bartering, but I can tell you there's rarely such a thing as a simple, two-way trade in audio. They inevitably get complicated, so don't be surprised to find that the amount of time a certain piece of equipment actually stays in your system is often less than the time it took to set up the deal in the first place. Just learn never to throw away any boxes.

Now you'd think I'd despair as I sit here listening to my boom box, but all this audio wheeling and dealing makes me hopeful of someday actually finding that world class system. I just know it's out there. I imagine a guy in New Jersey has the speakers, and right now he's adding just a little more damping material to the box. The nearly perfect amp is making the tweak rounds somewhere in the midwest and, along the way, someone will put in a part that will make all the world of difference. And in Spain, a mad scientist type is auditioning various rare and wondrous caps in my future preamp.

My perfect, world-class audio system is already in motion and all the parts are coming together beautifully. Before long, UPS will be delivering it right to my door. With all that speaker cable in-house and my trusty REL tuner, you might say I'm ready for it. And this time, with any luck, I'm going to figure out a way to bolt it down to the floor before I let it out of my sight.

SOUND PRACTICES

A JOURNAL OF AUDIO TECHNOLOGY SUMMER 1994 FIVE DOLLARS



Audio Kit Revival!

Vol. 2:#2 Issue 6

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History Lessons

There is a lot of confusion regarding the cultural significance of vacuum tube audio in general and single-ended audio in particular. All of a sudden, we are confronted with a harvest of new stuff which apparently has a lot to do with very, very old stuff. Some mainstream journalists were quick to dismiss the whole phenomenon as a "retro" movement, a term of pointed disdain in high-tech circles signifying an unnatural preoccupation with an imagined past. "Now is better" is the cry of the old guard rallying in defense against this blast from the past.

Well, now *is* better. But "now" is composed of our collective and individual past experiences and it offers a diverse set of possibilities for the future. The rise of single-ended amplifiers is a NOW thing. You can build one of these so-called "retro" amplifiers with parts manufactured last week and designed after the Intel 486 chip was well on its way to obsolescence. Recent changes in World sociopolitical structures provided the side benefit of new manufacture and even new design vacuum tubes for audio. Yes, now *is* better — especially if you're into certain kinds of "retro" tube gear!

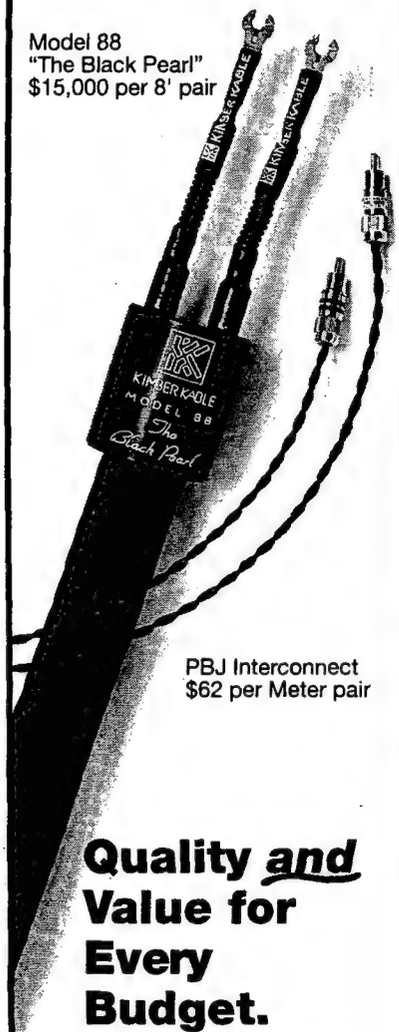
Although there is a romantic reflective aspect to the current reconsideration of foregone audio technologies, those involved in this movement are excited about future prospects and see themselves as working to make NOW better until we get to the future. Sure we have come a long way since the first 300B rolled off the line back in 1935, but this is not to say that a 300B can't take you today to a place you have never been before, somewhere you might discover that you really want to be. As new concepts blend with old, new directions emerge. Why shouldn't history offer lessons in audio as it does in politics?

Technological progress rarely traces a straight line. If it had in audio, our systems would be so good by now that further development would be strictly academic. As it stands we have a long way to go. More often than not, a step forward in one area of performance is repaid by a step backwards in other domains of evaluation. Transistors rode to dominance on economic advantages but it took at least 25 years before they even came close to the vacuum tube as a reproducer of music. A dramatic advance in, say, efficiency, size reduction, or cost per unit may temporarily blind us to shortcomings but over time our initial over-enthusiasm is moderated by experience. Such is the engine of progress that it drives us between one incomplete solution and another.

Since the values of the modern audiophile radically depart from those of the market-driven engineering perspective which officially defines progress, maybe it's time to reassess technologies passed by in big industry's quest for economy, efficiency, and miniaturization according to our own uneconomic aesthetic ideals. Many possibilities appear on the horizon when we break out of the tiny slice of time that is 1994 and take as our playing field the entire range of technologies which came to pass during our century of electrical sound reproduction. Let us make our own choices with our own special goals in mind.

Like postmodernism, the new wave in audio draws on and juxtaposes wildly disparate influences, from points scattered across space and time. But in contrast to the jaded cynical superficial attitude of the postmoderns, the core of new audio is heartfelt excitement about possibilities and a joy of participation in the giant experiment. In this sense we have a rebirth of modernism in the classical sense with a 1994 thing going on. Fellow adventurers, modernism might even be better the second time around!

Single-ended audio is not vintage audio. However, one of the crucial lessons that many of us have learned from living with the best classic components of the first electric century is that there are more possible musical sounds than the latest Recommended Components list offers. Some widely neglected devices can really play music. We surely haven't heard the best yet, but maybe we will get there during the next audio century by keeping an open mind today.

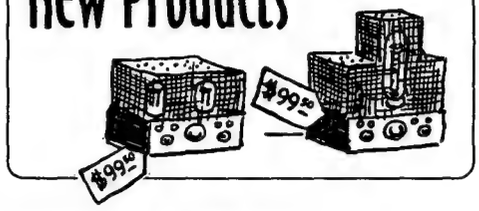


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VAIC Valve Italia

Vaic Valve is offering a line of new design, European manufacture power triodes created with the discerning audiophile in mind.

The Vaic Valve VV30B will be of particular interest to the readers of this magazine. This triode can be substituted directly for the 300B, but it is not a mere copy of that classic tube. The VV30B has a redesigned mechanical structure, gold plated grid, and graphitized plate. It also uses a ribbon filament in parallel instead of the round extruded filament used in the original WE 300B and currently manufactured versions. The working lifespan of the VV30B was tested at over 10,000 hours by an independent Swiss testing laboratory.



The mu of the VV30B is higher than that of the 300B, therefore less input drive is required. According to the manufacturer, the same operating voltages which produce 7 Watts out with a 300B produce 12 Watts out with the VV30B. Several other output triodes are in the works, including higher power versions.

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Svetlana Electron Devices

This venture is a joint stock company formed between a privatized manufacturing facility in St. Petersburg and an American consortium. The Russian manufacturing facility, probably the largest vacuum tube plant in the world, has established a reputation for quality in the broadcast and industrial markets.

Svetlana is very aware of the growing demand for high quality audio tubes and they are approaching this market from three sides: exact plug compatible versions of Western tubes like the 6550, 5U4-G, and EL-34, excellent quality Russian designs like the 6P4SS, and totally new design thoriated tungsten class A triodes specifically created for audio. Russian 300Bs and 6B4-Gs are currently in development.

Interested manufacturers and OEM suppliers can contact George Badger, VP and Director of Marketing, for more information.

Svetlana Electron Devices
3000 Alpine Road
Portola Valley, CA 94028
415-233-0429 voice
415-233-0439 fax

Kit Frenzy!!

following the third path to top sound

by joe roberts

Back in the Dark Ages when the first issue of *Sound Practices* hit the streets, single ended triode amplifiers were the exclusive province of the intrepid DIYer. If you wanted it, you had to build it.

Yeah it was fun back in the old days (last year), but it was a bit lonely. If you were interested in triodes and single-ended stuff back then you were likely to have enormous phone bills because the only two people who understood what you were talking about lived in Montana and Florida.

Two years ago, you could still find N.I.B. Western Electric 300Bs for $75 and only exporters were buying them since only a few crazed builders and Western Electric collectors had amps to plug them into. Over the past year, single-ended audio moved from being an exclusively DIY pursuit to a legitimate conceptual suburb of high-end audio. Mention that you have a triode amp down at the audiophile society meeting these days and you are more likely to get a request for an audition than the traditional blank stare.

Sure the tired hi-end market was ready for something novel and fun beyond new digital formats and the SE explosion gave audio journalists something to discuss besides ABX testing. Nonetheless, the enthusiastic reception of SE triodes in the established press points also to the sonic merits of this technology. This stuff does all the Official Audiophile things well: Image, detail, back wall, yak, yak, yak. But a good triode amp also plays with a breath of soul that is rare in the usual run of commercial gear.

Fortunately, the prospect of listening to triodes is becoming more and more realistic as small to medium sized manufacturers arise to meet the burgeoning demand for store-bought products at various price levels. A niche industry catering to the special needs of adventurous DIYers rose up out of nowhere simultaneously. It's getting to the point where we hear about new tubes, transformers, amps, kits, etc., several times a week! Things are really starting to get interesting. As good press on triode amps accumulates in the mainstream magazines, the market can only get better.

One particularly heartening development in the prevailing audio revolution is the resurgence of kits. Kits are a cool idea, once popular before they started building electronic gear with giant robots. Kits can help us recover the lost "hands-on" aspect of our hobby that many of us need in an era when you can't even tinker with your car without a 32-bit protocol analyser. Everything in sight these days is a soulless "No User Repairable Parts Inside" black box appliance.

The kit is the great leveler. You can be a total novice at electronics and still jump right in. You'll be less of a novice at the other end. Most of what you learn is basic soldering and assembly technique, but you will also catch on to the idea that, on one level, any amp is simply a pile of parts. This can do a lot to demystify electronics. It's more like plumbing than audiophile journalism suggests. Every reviewer should build at least one kit in his or her life, I say.

Novices take heart: A service manager for former kit giant Heathkit wrote in QST magazine back in the 50s that sometimes knowledge and experience could even be a bit dangerous in kit building. While beginners tended to cling to every word of the instruction manual, old hands at building would often invent "shortcuts" and skip sections of the manual, typically leading to unforeseen disaster or at least lots of extra work.

If you are ready, willing, and able to follow directions, the probability of making some weird mistake you never even thought about is greatly lessened with a kit. Most problems can be traced to failure to follow instructions. And if you do screw up you can get somebody to help. If you can't get your scratch-built triode-wired single-ended cathode-coupled 6AR5 amp to work, light a candle and pray for divine inspiration.

In addition to providing a clear program of action and a complete collection of parts, kits usually offer a sound economic rationale as well. Often a kit sells as a turnkey package for less than you would spend to buy equivalent parts and materials yourself, especially when you factor in phone bills, time, and shipping charges. Sourcing non-standard power resistors and other obscure parts is the kitmaker's job, not yours. Rescues you from dozens of phone calls and $30 minimum orders when all you need is two 880 ohm resistors.

Furthermore, no investment in specialized tools like chassis punches and rattail files is required for kit assembly. You can get by with a soldering iron, standard hand tools, and perhaps a basic digital meter. You won't have to do any metalwork on the kitchen counter, so you don't wind up with razor-sharp metal filings stuck in the carpet, just little blobs of solder and lost nuts and bolts. As far as I am concerned, learning how to solder and do routine electronics assembly isn't a big thing. The ability to do decent looking metal work, on the other hand, requires patience, skill, LOTS of practice, and a serious workshop. I don't have any of the above.

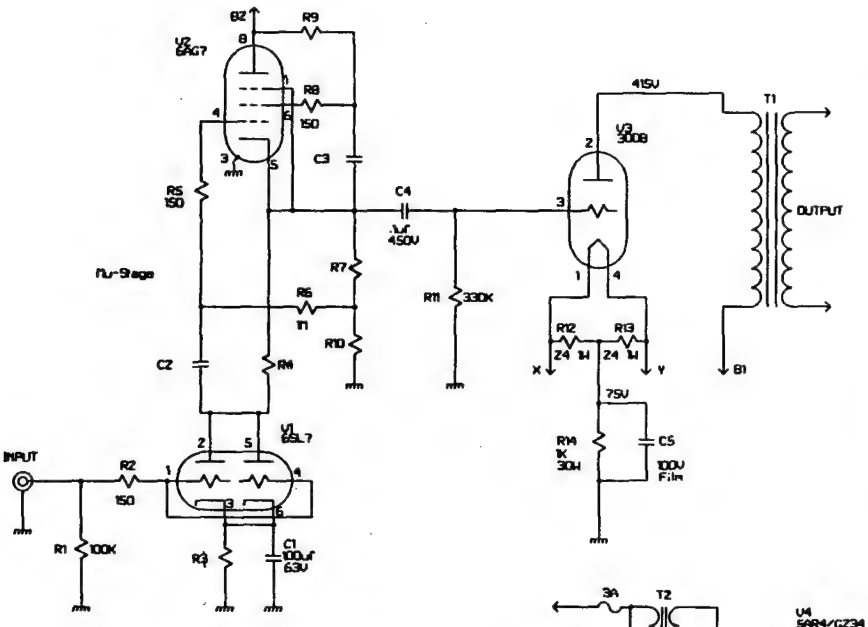
The question "How do I build an amp?" is like the question "How do I fix a car?" It's not that hard, if you know how. Unfortunately, learning how is a medium-to-long-term project and everybody wants to get building NOW, if not sooner. If this sounds familiar, whip out your credit card and call a kit dealer.

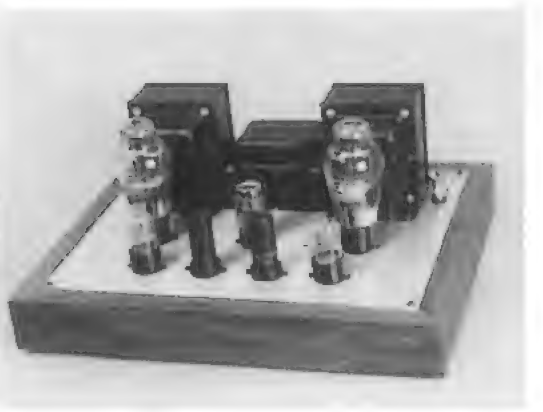
The psychic payoff of kit building is enormous. After a few nights of interesting and engaging work, you can be listening to an amplifier YOU built. Impress your next date: "Yeah, baby, I built that amplifier. Like that midrange?" Rediscover the rewards of actually doing something tangible in a push-button world.

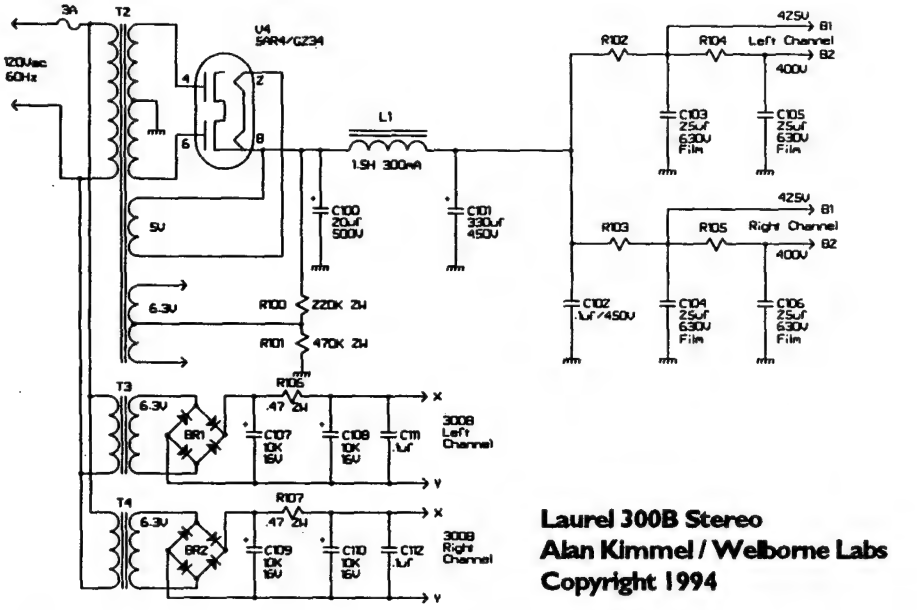
The psychological rewards and economic advantages of kits are certainly considerable. However, the reason hobbyists build kits is to get the equipment at the other end of the process. Right now, there are some very interesting products on the kit market. Even though I'm a notorious trashpickin' cheapskate scratch builder myself, I was anxious to hear some of the current crop of SE kit amps because on paper they seemed to offer potential for high performance at a level of investment many hobbyists can tolerate.

Welborne Labs Laurel

At $1600 and up, the Welborne Laurel stereo and mono amplifiers are the higher-priced entries in the US kit market. With the Welborne kits, you can get into a serious triode based







Laurel 300B Stereo
Alan Kimmel / Welborne Labs
Copyright 1994

system for the cost of an Adcom-555 and a pair of Vandersteen 2C. You probably need to have gone through the 555/2C phase yourself to recognize how far ahead you would be with this 300B kit and a pair of efficient two ways.

Since Welborne's in the audiophile parts business, this amp is loaded with fancy designer parts. Outputs are Magnequest FS-030s on the stereo amp ($1600), DS-025s or FS-030s on the monoblocks ($1620 or $1900/pr). A "stock" Laurel comes with Golden Dragon 300Bs, 6SL7s, and GZ-34, and a pair of new old stock 6AG7s. Kimber Kaps are used in the audio circuit and as bypasses for the SCR polypropylene filter caps.

Welborne is receptive to the idea of working with the buyer on parts selection, a refreshing alternative to a common high-end manufacturers' stance — "We auditioned every fuse holder on the market and this one is the most transparent" and so on. As a symbol of kit building freedom of choice, Welborne packs each unit with both Allen Bradley carbon composition resistors and fancy Roederstein metal films. "Have it your way," is the order of the day.

The Laurel I got my hands on was an assembled stereo unit. Quite nicely assembled at that. I almost hated to dive in with a soldering iron and really get into checking out the amp. Now, if it were a borrowed Audio Research, I wouldn't even want to open it because I might mess up the paint on the screws and lower the resale value by $300. But this is after all a KIT amp. Kits don't have to stop being built. I saw it as a project waiting to happen.

I called Ron Welborne and asked, "Say, you wouldn't mind if I tried an experiment or two with the amp, would you?" Heck, Ron not only didn't mind, he encouraged my experiments. Got the same response from Dennis Had over at Cary about the SE-1. Both kit designers were actually eager for hot tweak tips to pass along to builders to try. I really appreciate that attitude.

Since I'm used to spray painted Bud chassis homebrew monstrosities, it was a bit of a shock to my listening room anti-decor to have the extremely handsome Laurel on my mantel. If I ever build an amp as nice looking as the Laurel, Joyce might finally stop moaning about the fact that I gave her Akai mini-system away five years ago. With its polished brass and walnut enclosure, the Laurel looks handcrafted rather than manufactured. It would be at home in a mahogany paneled den with green leather armchairs. Got that exclusive men's club thing going on. The entire assembly fits on a compact 14 X 17 X 2" chassis. With all those burning Class A tubes on one and a half square feet of real estate, the Laurel would be nice to cozy up with during a snowy evening. (Right now its 105° in Texas, by the way).

All versions of the Welborne SE amps use a mu stage driver stage designed by Alan Kimmel. This circuit is a variation on the popular mu follower circuit optimized for use in power amps. A general idea of the circuit implementation is given above. The complete schematic and other relevant engineering data is available in Welborne Labs' latest design manual and catalog, a thick book of schematics and useful data worth every bit of the $10 asking price. Further insight on the mu stage is also provided in Alan Kimmel's 1993:2 article on the topic in *Glass Audio*.

The assembly manual and layout are logical and should be easy to follow for the builder. Most of the parts are attached to a few epoxy terminal strips that run the length of the amplifier. Basically you mount the transformers, tube sockets, and terminal board in the amp, then install the parts in layers as instructed by pictorial diagrams. Once you get everything in there isn't too much leftover space, so forget about strapping a bank of oil filter caps rescued from an old radar console underneath.

Laurel Sound

Out of the box, with less than 50 hours burn-in time at Seth Goldwin's pad, the Laurel had a touch of zing, as I expected based on Seth's comments and my previous experience with freshly built gear.

The last few amps I built used Magnequest transformers and I found that they require up to two weeks of nearly constant play before they fully settle down. Poly filter caps also take a few days to mellow out. Same probably goes for everything in the amp. I don't remember such dramatic burn-in effects with store-bought gear. I suppose most manufacturers put some hours on a factory unit before it ships.

Like everything else in audio, the whole question of break-in is under dispute. Psychologists often attribute such effects to perceptual recalibration, where the perceived break-in is actually a by-product of the listener getting used to the particular sonic character of a given device. Although I agree that man has a high capacity for self-delusion, I believe that break in is real. Fooled me, anyway.

The Gauss 1502 compression driver tweeters I use for the top end in my Edgarhorn/Onken system are a mixed blessing. With the right amp these tweeters really sing but with some otherwise respectable equipment they turn into audio-frequency death beams. Over the years, I have developed a liking for systems with mildly sharp speakers and slightly soft amps, or at least amps that have a musical rather than a clinical top end. Altec 755C or Lowther PM-6s in my 4" throat Edgar horns also give me a squeaky clean sound, but they are far more forgiving than the pro-sound tweets.

I usually bi-amp with a triode amp on the mids and tweeters. Accordingly, most of my Laurel listening was done with the amp on the mids and highs, 350 Hz up, but I also wired up the system with the Laurel playing full range. Until I get a chance to build a PP triode bass amp, I am using a Dynaco ST-35 I borrowed from a friend as a bass amp on the Onken/Altec 416. Even with a wimpy Dyna bass amp, the bi-amp setup sounds better overall because I don't have to pad down the mid horn to match output levels. The bass was actually much more natural with the Laurel but I couldn't take the midrange quality losses with an attenuator in line, so I mainly listened bi-amp. Anyway, after a week of nonstop listening, I decided that the Laurel still had a pinch too much lower treble information for my system. A subtle thing and probably as much to do with my speakers as the amp. Anyway, I was looking for an excuse to start heavy tweaking.

My first experiment was to unbypass the poly filter caps. The 0.1 mF Kimber Kaps shunted across the filter might offer lower impedance at high frequencies but the SCR caps are okay by themselves. With a film bypass cap, they can get a bit too lively sounding — an advantage in some cases but not what I needed. After I yanked the bypass caps, the amp smoothed out enough that I was happy. Power supply components have major sonic effects in SE amps because the PS is *in series* with the audio stage in SE.

Continuing to experiment, I installed four Audio Note paper in oil caps for coupling. The AN caps, while a touch on the laid back side, are free of the melodramatic quality some people don't like in classic oil caps like Vitamin Qs. They offer a polite tonal balance and poise without squashing dynamics. A tiny bit soft on the leading edge but the overall effect is very natural and involving. They provide just enough bite for a convincing illusion of reality. A friend once suggested that a good system is one you can fall asleep listening to, but not one that puts you to sleep. The AN caps will give you a comfortable sound that is still exciting and very engaging.

Another capacitor I have been interested in lately is the Hovland MusiCap, a polypropylene and foil type. I have always been partial to a nice oil/paper cap for power amp interstage coupling, but after a week of living with Wavelength Audio's superb MusiCapped Cardinal amplifiers, I began to reconsider my position. I tried an SRPP driver stage in a 300B amp with Magnequest FS-030s, but it didn't sound like *this*. The Cardinals gave a lot of overused review-speak terms new meaning for me. Want transparency, detail, and accuracy that doesn't singe your mustache? Here it is. I figured the Hovland caps played a part in the Cardinal sound so I wanted to try 'em in the Laurel.

Indeed, the Hovland MusiCaps were a killer in the Laurel, even though it sounded very different from the Cardinal. If you want see-thru, high-definition, detail *and* listenability, try the MusiCaps. Where the Audio Note caps had a bit of smoky after-hours jazz club flavor, the MusiCaps had that sunny afternoon chamber music on the patio sound. Know what I'm sayin'? Oh, well.

Basically, I had the Laurel for three weeks and during that time I had three different sets of caps in the amplifier. All I can say is, you folks who find cable swapping and resonance tweaks engaging should look in to cap swapping as a new hobby. In these simple no-feedback amplifiers, each "passive" component has a truly radical effect on the sound. Sure, you can hear parts changes in push-pull feedback amps too, but here it is a different order of magnitude. I had a real blast experimenting. The range of possible sounds you can craft by swapping low cost parts is mind bending. The Laurel can assume many guises.

Throughout my experiments, the Laurel maintained a sense of tight control and focus. This amp is very fast and punchy. It had the snap for Buddy Guy and just the right amount of richness and color to give female vocals the appropriate emotional twist. The bass performance of the Laurel was highly controlled for a SE 300B. It would be a good choice to run appropriate speakers full range. If you think SE amps can only sound "old fashioned" or hopelessly tubey, you haven't heard the Laurel — or most other modern SE amps, for that matter.

Additionally, the Laurel has the vivid 3-D presentation that instantly lets you know you are listening to an SE triode. This is one of the main things you are paying for when you invest in triode amps. With a good SE amp, the music just floats in the air — a pleasant, almost psychedelic illusion that never wears away.

Don't mistake this little essay for a serious review. I mainly used the Laurel as a midrange amp with a non-standard speaker system. If anything was matched to +/-1 dB, I'd be very surprised. I just wanted to "check it out" in my natural listening and tweaking mode to see if it would give me the level of musical impact I expect from a 300B SE. It sure does. It is a really nice amp.

After playing with the Laurel and the Cary SE-1, I am even more excited about kits. Both products were like "fun in a box" and each gave up some real good music for the money (and high perceived value overall) in their respective price classes. A kit can give you most of the fun stuff of scratch building without any of the dog work and tedium. Since I grew up in a silicon universe, I missed out on tube amp kits the first time around. I'm sure glad they're back!

SINGLE ENDED ME



BUILDING THE ALMOST AFFORDABLE SE AMP KITS

BY SETH GOLDWIN

From high-end zombie to amp building he-man in just 32 hours

When I needed new tubes for my one-time *Stereophile* Class A rated amplifier earlier this year, I went down to Stereo Exchange. They had just installed the new Fosgate speaker system in their THX room, so I popped in for a listen. Playing the reprehensible pseudo-jazz of David Grusin off some Lucas Film demo disc, the system enveloped you in a 360 degree panorama of listless, cardboard thin sterility, with a kidney punch of BIG BASS thrown in once every little while. A salesman told me this was what the recording sounded like, because this was an accurate system, and that if I didn't like it then I didn't like the recording 'cause that's what I was hearing.

And they didn't have my tubes. Another salesman suggested I try Fi at 30 Watts St.[1] I'd never heard of it, but loved the address, so off I went. Funky little street, funky little store with almost nothing in it. Some clearly homebrew 3-ways, a couple of serious looking tube amps and a turntable. Chatted with the all-time nice-guy owner, Don Garber, who sat me down and fired up the hidden CD player. Hoh, seeee-IT, man, here was MUSIC! I'd never heard a presentation like that, NEVER. Not one single thing was escaping the notice of that little amp: smooth, easy, relaxed, but filled with crystalline detail. It was a major moment for me, that first introduction to the single ended triode amplifier. And by the time I left the store I had but one thought: I ain't gonna' work on Maggie's farm no more. To hell with hi-fi, I want that single ended SUPER-FI!

I took home Fi's utterly fabulous, and close to affordable ($1,475) 2A3 amp all primed for ultimo sonic bliss. Not so fast, fella'. Not enough oomph to drive any of my stick-in-the-mud backwards-into-the-future low efficiency speakers. A truly fantastic sound, but only at volumes lower than I regularly listen. And I can't afford to even think about the $4K 300B monoblocks.

I also picked up my first copy of this magazine during that visit. Read it and started grokking a fundamental fact: you don't have to buy at the store, you can build at home. Hmmmmm. I've been into audio since I was a kid, but my only building experience was to permanently and irrevocably destroy a Heathkit solid state amp kit when I was 15. I know, like, zip about electronics. I asked for advice. Old hands said, "Oh, just go build something: look at the schematic, figure out what the parts are, figure out where the parts go, then solder 'em together. It's easy, man, I built my last amp during my coffee break at the Sup 'n' Sip." So I started looking at schematics. I figure, hell, I went to college; look at the geniuses at the TV repair shop—how hard can it be to read a schematic?

Umm, pretty hard. After a while I was able to see that a squiggly line was a resistor and a curly-Q was a transformer and a little triangle was probably a diode, but SO WHAT? How do you keep 'em from rattling around inside their little coffin? What do you use to string 'em together? Where do you get a tube socket? How do you get all those nice, neat holes in the chassis for things to stick through? And, for that matter, where do you get a chassis?

ENTER KITS

So I started looking at kits. The two cheapest kits around are the Audio Electronics Supply SE-1 and the Audio Note Kit One. In their basic forms, with Chinese tubes, the SE-1 is $800, the Audio Note is $1,150. Unable to hear ANY of them, I bought the Audio Electronics Supply SE-1 because it was cheapest, and it's available. That was about the extent of my research. Since I am unable to look at schematics and figure out what the resulting sound might be, throwing my money into the air and seeing where it landed was about all I could do. Oh, I also asked around, and one guy said no, and another guy said yes. Cleared things right up. After I bought the kit, I was asked to write up my experiences as a first time builder and kit amp shopper for this mag. Using my clout as a big time reviewer, I wangled an Audio Note to build and audition the next higher-priced option in the kit marketplace.

AUDIO ELECTRONIC SUPPLY SE-1

I called AES on Tuesday and received the package on Wednesday! Bravo! A company that understands the audiojunkie's need to have it right NOW! The kit was very nicely packed, each class of parts wrapped in its own custom plastic bag. Parts quality is a little hard for me to judge, as I don't have the experience. The resistors are plenty cool looking, though—black Dale milspec jobbies. These LOOK a little tougher, that tad bit MEANER, than the Holcos and Radio Shack junk I've handled before.

The SE-1 is a straightforward 100% class A, single ended design. It's assumed that you will use it with 300B tubes, but it can easily be rewired to use 2A3s or any other tube of that ilk that you may have lying around. There is no global feedback. The input tubes are 6SL7s in an SRPP configuration. The output transformers have been sourced to AES from somebody or other, and are said to be specifically designed for use in the SE-1. Output and power transformers are 200% duty cycle.

I ordered my kit with the oil-filled coupling cap option (an extra sixty bucks), so along with the Nichicon Muse electrolytics, for the filtering and the Kimber Kap kuties that

1 — Fi is now operating on a mail-order/by appointment basis out of a Brooklyn workshop. Don can still be reached at 212-966-0831.



Audio Electronic Supply SE-1

do the bypassing, I got two metal case tubular caps with the highly-valued—highly priced at any rate[2]—Vitamin Q logo. AES hawks this option with the unbelievable cornball line that high frequencies "will come through as if *liquid syrup were filling the sound stage*"! [ed.- Aw, you're just grumpy cause you fell for that country breakfast yourself, City Boy. What do you want? Wine metaphors?]

The SE-1 manual is decently brief, yet thorough. It is 100%, absolutely required to sit down and go through the entire manual before starting in. This is not negotiable. You don't have to understand everything (I hardly understood anything), but you need to have some feel for what the construction process is all about BEFORE you start constructing. Without a big picture of the job, you're some idiot automaton, goose stepping through a fascist character building exercise, and you'll miss out on part of the educational experience.

I am INTO building things. I love the feeling of walking through a series of predefined steps, slowly working up from foundation to finished item. I don't know about you, but I gain knowledge of a thing by *handling* that thing. No matter how many books I had read on the subject by the time I was 15, nothing gave me an approximation of the real feel of a woman's breast until I finally got my hand inside Becky's bra. Now I'm not saying building a kit is gonna' bring back THAT kind of intense satisfaction, but it is way more fun than going down to the local hi-fi salon to get snowed by the salesgeeks. Successfully building your own gear is the kind of thing that makes you proud to be a MAN, if you know what I mean. And you learn.

Remember where we're trying to get to: read the schematic, lay out the job, build the unit. For me, the point of a kit is to learn how a pro does things. It's an exercise in building sense memory, like those wacko machines that you strap yourself into so you can learn Arnold Palmer's golf swing. So, the point isn't just doing the thing, but learning WHY the thing is done that way.

Two double sheet sized drawings are inserted into the back of the manual. One is the schematic, which made no sense to me until I had built the thing. Now I can sort of follow it. The other insert contains a labeled legend to the holes on the top of the chassis, and another legend to the hardware bits underneath. This is conveniently keyed to the upside down chassis, and was pretty easy to follow. It did take me a little while to catch onto the connection between letter/number references in the manual, this chart, and the chassis itself, but once I got oriented it was pretty easy to navigate. This insert should be taped to the wall above your work bench because you will be referring to it constantly through the rest of the process.

The construction process proceeds in a pretty logical and reasonable sequence. First you stuff the chassis with all the bits of hardware. Most of the things that go on the top of the chassis have little things attached on the bottom as well. This is clearly explained and the details of mounting each piece of hardware are detailed via explicit drawings. The next step is building some wire subassemblies which get used later.

And then you start wiring. There's a fair amount of wire and it goes all over the place. The manual suggests running all the wires, resistors, caps and other stuff first, and only after everything is placed doing any soldering. This makes sense because most of the connections are made through terminal strips, some of the lugs of which end up holding a lot of wire ends. It doesn't take much soldering experience to learn that it's a LOT easier to deal with a nice virgin joint than to solder something into a lug that's already been soldered. However, I'm not sure I completely agree with this suggested procedure, and I'll come back to the reason in a moment.

The wire supplied is mostly 20 ga. solid core, with a few lengths of 22 ga. twisted pair, and a few other specialty types for specific applications. At the end of the day I had reasonable amounts of each type and color left over, so at 30 cents a foot they didn't cheap out here. The Edison Price binding posts and other hardware is of fine quality. Where they did cheap out, however, is on the crummy plastic front panel switches. When I wired the on/off switches backwards, and had to desolder and rewire, the heat caused the contacts on BOTH switches to melt right out! The picture on the front of the manual shows nice metal toggle switches. What happened?[3]

The wires and parts placement proceeds by class: that is, first the twisted pairs, then the black ground wires, then the yellow wires, red wires, capacitors, resistors and finally the transformer wires. By the time you are done, what looked like all the room in the world is CROWDED, especially around the 8 pin input tube sockets in the lower left and right. There are a bunch of fiddly bits in

2- ed. - Vitamin Qs were *never* cheap. The major end user for these high class parts was always Uncle Sam. Thirty bucks for a low production (these days) high voltage industrial/mil grade cap built in a tinned brass tube with a glass to metal hermetic seal ain't too bad. Check the pricing on Vit Qs in the latest Newark Electronics catalog. Makes that fancy tweak stuff look cheap in comparison.

3- ed. - Most switches have "plastic" around the contacts. They call it "insulation." Meltdown can be prevented by using a clip-on heatsink.

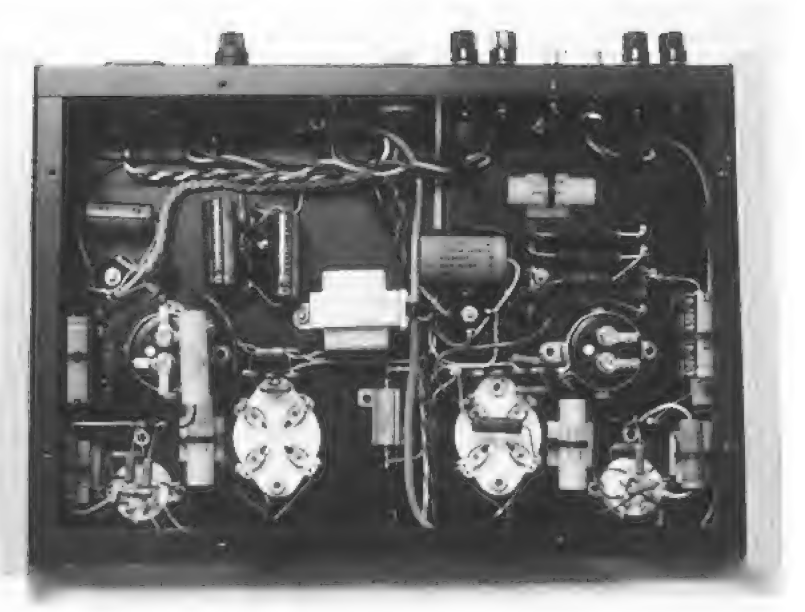
here, and figuring out how to route the teensy-tiny jumper from pin 2 to pin 4 and place the resistors that pretty much have to stack up on each other and keep all leads from shorting and keep all the little pieces from falling out of the tabs they're in every time you breathe is a major pain in the butt, dude.

There are two real dangers here, both of which I experienced firsthand. The first is that with all the layering of connections it's pretty easy for one to fall out. So you finish some step and look back over the thing and see a little yellow wire just hanging out, going nowhere. Which means you jostled the amp and it fell out and you have to CAREFULLY go back over the whole thing to get it back in the right place, then make sure you didn't knock something else out while you were fixing the first thing, and so on. Also, there's no master key to what all the wires at any one connection point are supposed to be so you have to thumb back through ALL the connection drawings each time you suspect something slipped, which is another pain.

Which brings us to the second danger. After a couple of slipped connections you start catching on and making your wire leads longer so that you can wrap them around the lugs or tabs you are connecting to.[4] I don't really like doing this because it then becomes a major headache to desolder the connection and loosen the part or wire if you want to change or fix something, but at least they don't fall out. BUT, if you've got little wire pieces hanging out and space is tight and you're paranoid about unconnected wires and you happen to fasten one of those component tails across a tube socket from positive to negative and think everything's jake 'cause the extra connection is hidden under two layers of resistors where you can't see it and you plug the thing in, and get SMOKE and a BURNING SMELL, well then you did just what I did. I yanked the power, but, oh man, that one chilled me to the bone!

It took quite a while to work through the circuit and find my mistake. By that time it was 10:30 at night, and of course I had blown the fuse and had no replacements, so it wasn't 'till the next day that I found out that in fact everything was just fine except for a char mark on a resistor.

4- ed.- It is good procedure to always make a good mechanical connection at the joint *before* applying solder, as you learned the hard way.



AES SE-1 Underside View

Which brings me back to my major complaint about the build procedure that I mentioned above. Remember I'm a novice, and I'm assuming the kit designer is a pro, but it seems to me that if I were doing my own amp from scratch I would want to build up each of the connections and then solder it down, proceeding around the edges of the chassis then into the middle where there's more room. I'd have fewer connections slipping out, less chance of goofball mistakes like the one I made, and also less chance of charring unrelated wires with the soldering iron as I dug through layer after layer of wire to get at the joint to be soldered.

My only other quibble is that there should be some mention about how to identify capacitor polarities, especially because there IS a warning that "an explosion will take place if not installed properly." That kind of got my attention. A slightly frantic call to AES got me the answer. On the electrolytics, there is a stripe on the side with an arrow pointing to negative. Also, the negative side is shiny, positive is dark. On the Vitamin Qs, if you hold it so you can read the writing on it, the positive side is to the left of the writing. The Kimber and other Sprague caps are so clearly marked even I could figure them out unaided. By the way, only electrolytic caps pose the danger of explosion when reversed.

Ah, one last thing. The phono plug you shove in to set the bias shorts across the circuit so when it's in there's NO MUSIC. That flummoxed me for awhile, and gave me a sinking feeling when I first hooked up the completed amp to the rest of the system because I had forgotten to take out the plug. Oh, and also it would be nice if there was a photo of the completed amp's guts in the manual. Not required, but it would have been helpful.

Despite these complaints, the manual does its job, and I was able to put the whole thing together in about 16 hours over two days. The built unit is an attractive, compact little beast, measuring 13" wide by 9" deep and a little less than 8" to the top of the tubes. It ships with wooden side rails to screw onto the chassis, but I hate that kind of nonsense, fru-fru designer touch and just left mine off.

SE-1 SOUND

The highs are like liquid syrup, the midrange is smooth as butter, and the bass, while exhibiting a slight golden brown coloration, managed to be both as fluffy and as substantial as pancakes. But, for some reason, I never feel like listening after about 11:00 in the morning. Sorry, couldn't resist.

After finishing the amp and plugging it in, I *hated* it. The thing was so smooth it sounded compressed. I had heard that oil caps take a long time to break in, so I played the amp hard for a week, and then started serious listening again. I still hated it, except for one day after some insanely complicated stuff at my real job, I found it relaxing. I got one of my audionut buddies to come over

to listen to it. By the third cut he was sound asleep! I called my least audio oriented buddy, the one who used to be a music critic, and got him to come over and listen. He said, "This is bad. You've lost that thing where you can hear all the music, but still follow individual threads." I was pretty bummed.

So I yanked the Vitamin Qs and soldered in some Hovland MusiCaps I got in the mail. Immediate, radical, MAJOR change.[5] The highs came out of hiding, images emerged from the fog, and it became possible to again discern detail. Least audionut buddy said, "This is good. Don't mess with it anymore." Most audionut buddy said, "I wish *my* system sounded like this." I started getting happy again.

In the circuit design description, it is claimed that a lot of attention was paid to "overload recovery" and I guess I believe that. The amp did not wildly distort even when cranked almost full up, driving inefficient speakers. I know for a fact it was into clipping territory, but that clipping was of the soft 'n' easy brand.

SPRAGUE CAPACITORS

VITAMIN Q® SUBMINIATURE PAPER CAPACITORS



These capacitors are the most widely used of all paper capacitors in commercial and military electronic equipment. Hermetically sealed in metal cases, they are electrically and mechanically designed to meet stringent operating requirements.

Impregnated with Vitamin Q, a substantially linear, controlled molecular weight, hydrocarbon polymer, which is exclusive with Sprague, these dependable capacitors are available for operation in two temperature ranges: −55°C to +85°C and −55°C to +125°C. Because of their Vitamin Q impregnation, these subminiature capacitors have a higher insulation resistance and longer life than comparable units with ordinary oils.

Sprague Subminiature paper capacitors exceed the performance requirements of military specification MIL-C-25A. A limited number of the ratings shown here are listed in the military specification and should be ordered by their MIL type designation where equipment specifications so require. (See page after next)

Listed below are the most popular insulated section (ungrounded case) capacitors. For information on other types, ratings, and tolerances, as well as on wax-impregnated units for absolute minimum size, consult your Sprague Industrial Distributor.

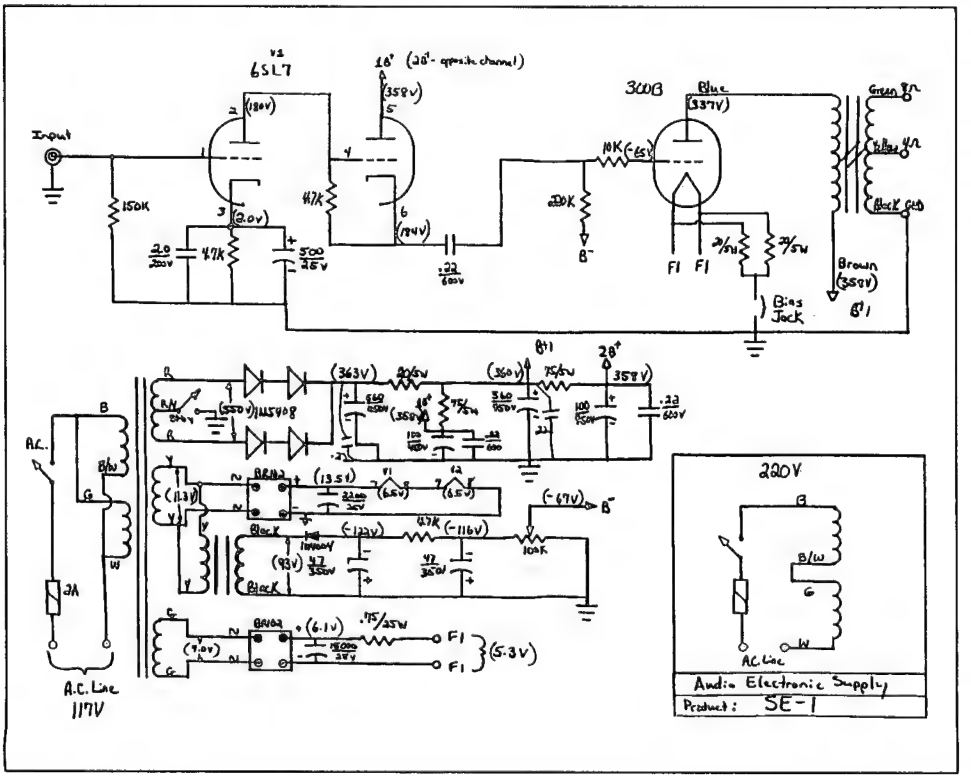
Vitamin Q ad from 1960 — First choice of guided missile designers everywhere

THE SE-1 IN MY SYSTEM

A few months ago I bought a few pairs of NHT SuperZeros and an SW2P powered subwoofer primarily for home theater use, but I've been so wowed by their high resolution and clarity that I listen to a LOT of music on them. In fact, I sold my ProAc Response 2s 'cause I felt I didn't need them anymore. The SZs have a sensitivity of about 86 dB, more or less average sensitivity.

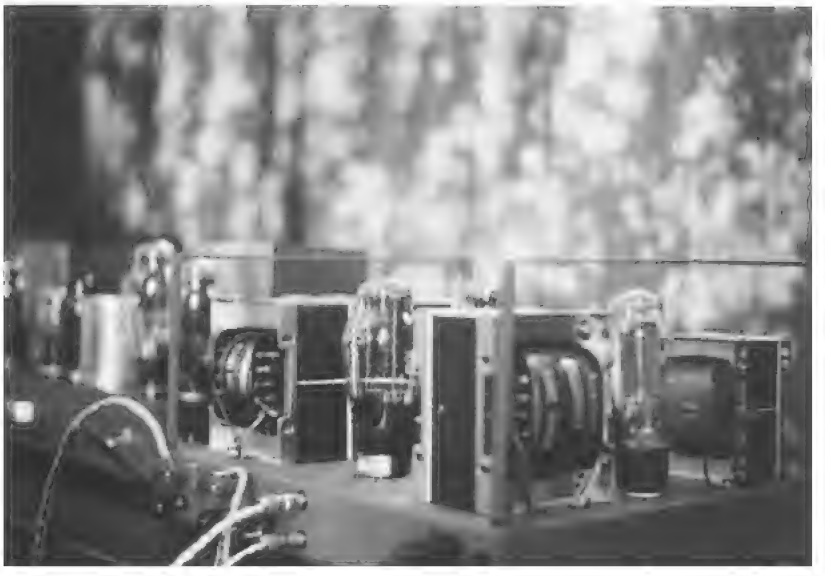
My other speakers are a pair of original QUAD ESLs which are famously weird in their power requirements. The SE-1 was capable of cruising volumes of 90 dB, and peaks around 96 dB at my couch, about 12' from the NHTs and 8' from the Quads in a 20' by 13' room. This is actually about the top volume limit I can regularly get away with as I live in a NYC apartment, and I'm pleased to find out that level CAN be reached with a SE 300B design and mainstream speakers. It could NOT be attained with the Fi 2A3.

Of my own two speaker sets, when I had the oil caps in, the NHTs came out a lot better than the Quads. The slightly blurry, mushed together sound of the oiled SE-1 was not looked upon kindly by the Quads. Also, the already somewhat tubby bass of the Quads was made much worse by the SE-1. The less demanding NHTs pushed on through relatively unscathed in comparison, especially when I rolled off the low frequencies using a homemade passive high pass



5— ed. - Vitamin Qs, the classic paper-in-oil cap, are not for every system or every taste. Ned Carlson of Triode Electronics writes in his Dusty Files II: "Vitamin Q caps are the subject of heated debates, with our customer response running from ecstatic to badly disappointed." If a full, dense, and super-rich sound is not what your ears or speakers want, try something else. But in a system with high resolution paper cones or somewhat aggressive speakers, like Altec compression drivers with cast metal horns, Vitamin Qs can provide magical midrange effects. You have to consider the overall system perspective. Anybody with extra unloved Vitamin Qs can send them to me.

Anyway, go ahead and audition a few caps. One of the advantages of a kit is the psychological ease of trying things out that you would never try on your Jadis.



Audio Note Kit One 300B SE

filter (my intro to DIY, of which I am VERY proud) and let the powered SW2P take over the bass.

When I switched to the Hovland film caps, the Quads clearly sounded better than the NHTs. The SZs vastly improved, once again exhibiting great imaging and coherent, detailed sound from top to bottom. However, the Quads improved even more, again becoming the premier midrange speakers I know them to be. The Quad bass was still bloated, but with midrange-oriented material, I got a solid 3-D picture of the music.

Even with the film caps, though, the SE-1 seemed to lack a little of the life I've heard from other SE designs. The best way I can describe the overall sound of the SE-1 is to say it has a soft front, with a rich thick back. The back part is good. You get a real sense of the shape and sound of bodies of instruments, and voices, in all their complexity. But the front part isn't so good. Without transient snap the music is robbed of it's sense of excitement.

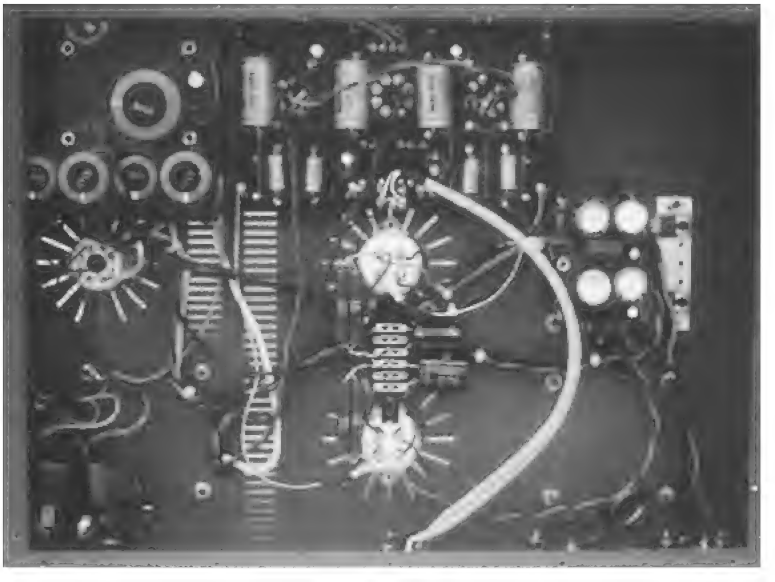
AUDIO NOTE KIT ONE

Like the AES, the AN is a 100% Class A, single ended design using 300B tubes with no negative feedback. It uses a single 6SN7GT double triode in the input stage which goes to a volume pot to allow for level tailoring. The output of this gain stage then feeds a 5687 twin triode driver configured in a series regulated push-pull circuit (SRPP). The signal finally winds up at the mighty 300Bs. The power supply uses a big ol' 5U4G rectifier and a cap input filter with a heavy metal choke.

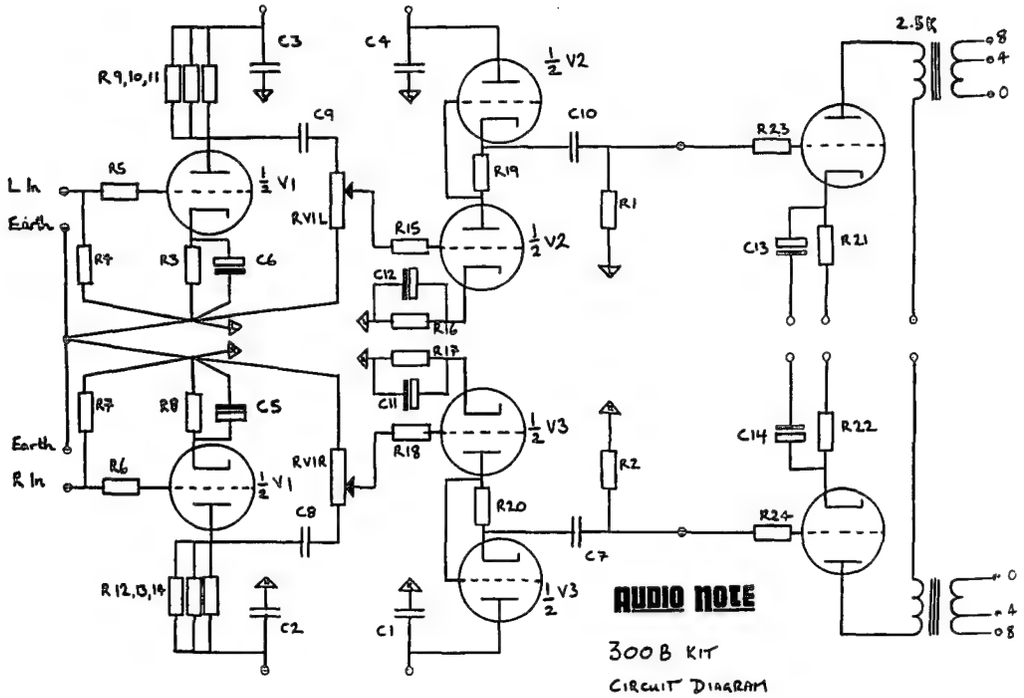
The finished product is not only BUTT UGLY, which I happen to like, but big too. Where the AES is a sensitive, caring guy who hopes your girlfriend likes him, the AN is just too macho to care. No attempt has been made to conceal that this is a piece of electronics. The transformers and choke look like a bunch of wire was stuffed into a brown paper bag and hidden in pieces of sorta' shiny, sorta' cheap metal. The chassis itself is painted in a very cool, lightly textured, industrial gray but it's still not gonna win any friends in the interior decoration business. Unless, of course, I'm your interior decorator. It measures 16" wide by 12" deep by 8 1/2" to the top of its (optional) tube protecting cover supports.

As one would expect, there's a lot of Audio Note branded stuff including about half the electrolytics and four paper-in-oil signal caps. The Beyschlag resistors are kind of wussy looking, but no doubt work just fine. All the transformers are, of course, Audio Note. The manual states "no real compromises were made in part selection" and who am I to argue? Later in the manual, they warn against part substitution, claiming that the amp was sonically balanced with these parts in mind. I ran out of certain colors of wire, but simply ad-libbed with another color and ended up okay. Be sure to get a ruler with metric markings before you start this kit. I can guess how long a foot is, but I ain't got a chance of getting 25 centimeters right. The AN manual is reasonably informative, almost detailed enough, and even has two or three JOKES. It walks the builder step by step through the process rather than referring to construction diagrams, although there are a few helpful drawings. It would be possible to build the amp even if you never read past the current step you were on. However, I strongly recommend you do a full readthrough before starting in.

Unlike the point-to-point wiring of the AES, the AN uses circuit boards. Because of this, the construction process as a whole was less useful to me as a primer on how to



Under the hood view of Kit One



AUDIO SECTION
V1 6SN7
V2 5687

RV1	100K log
R1 & R2	330K 1W
R3 & R8	680 1W
R4 & R7	470K 1W
R5 & R6	10K 1W
R9 - R14	82K 1W
R15 & R18	1K 1W
R16 & R17	820 1W
R19 & R20	820 1W
R21 & R22	each made from two 1.5K 9W wired in parallel
R23 & R24	3.3K 1W

C1 - C4	0.082 uF 630V
C5 & C6	100 uF 10V
C7 - C10	0.22 uF 400V
C11 & C12	220 uF 16V
C13 & C14	220 uF 100V

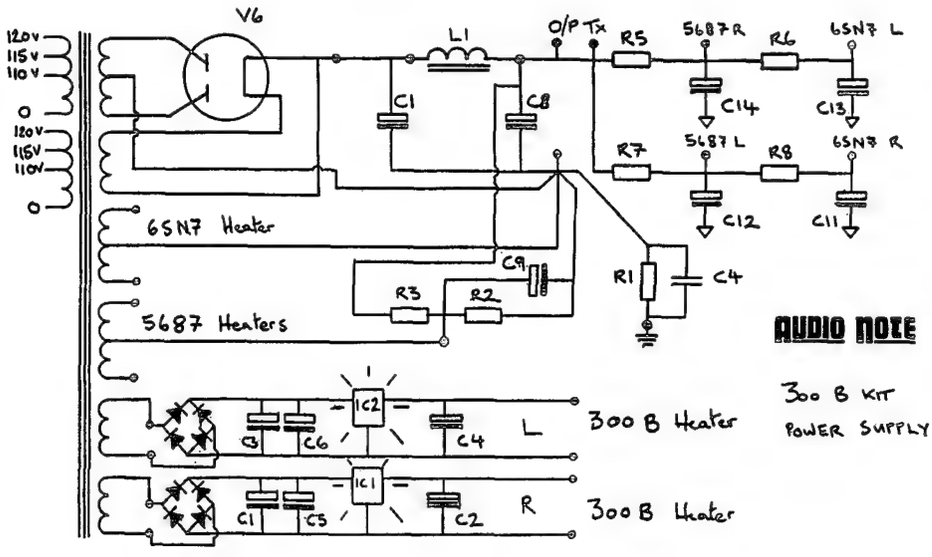
POWER SUPPLY

V6	5U4G
R1	100 1W
R2	82K 1W
R3	330K 1W
R5 & R7	2.2K 1W
R6 & R8	2.7K 1W

C1	33 uF 450V
C4	1nF 1000V
C8	220 uF 450V
C9	10 uF 160V
C11& C13	56 uF 450V
C12 & C14	100 uF 450V

FILAMENT SUPPLY

IC1 & IC2	78S05
C1, C3, C5, C6	4700 uF 16V
C2 & C4	100 uF 10V



Audio Note Kit One Schematic

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do my own stuff and also made it harder for me to understand the intricacies of how the circuit works. It did however help me to get into the head of board stuffers everywhere, and allow me to understand why this is completely dreadful work that every country, no matter how poor, wants to source off-shore to an even poorer country just as soon as possible.

The kit as a whole was beautifully packaged, with parts separated by step, or PCB, rather than just by component class. To build it, first you stuff the chassis with the transformers, choke inputs, outputs and so on. Then you stuff three smallish circuit boards. Then you wire it all together, test it, and get ready to groove.

Where appropriate, you solder things down as you go, not storing it up for one big, annoying solder-fest. I ran into one easily avoidable manual problem when I was trying to sort out the rather complex power transformer wiring. This process is covered by step 19 and 20. Step 19 is at the bottom of the (unnumbered) page and reads "...carefully twist together the following wires—see over." Then you turn the page and there's a chart of "Mains Transformer Wiring." I spent probably 30 minutes looking back and forth from the manual to the transformer trying to figure out WHY I would want to twist wires across the transformer to each other, before I threaded them through the holes provided on each side. Finally, I turned the page again and read through a few more steps and finally got that the list of wires on the top of THIS page was what Step 19 was referring to, NOT the chart on the preceding page which is what you use in Step 21.

Another manual complaint I have is in the Input Driver Board section. Just previously, you built the Power Supply, which uses an irritating method of attaching the resistors which requires you to trim, shape and tin each of the resistors to solder it to a pad on the PCB, rather than through a hole. Steps 5 through 8 cover the resistors for the Input Driver Board section and it starts by saying "Bend all the resistors to shape as described under the PSU board..." Well, DON'T. Unlike the PSU, the ID board has some pad mounted resistors, but most mount like usual just going through the board. If you're totally zonked on getting some sound out of this baby, and racing towards the end, and just blindly doing what the instructions say, YOU WILL BE MIGHTY SORRY!

In general, the manual, which starts out being extremely thorough and carefully holding your hand through each step, gets a little loose by the end. Clearly, someone got tired. Nowhere does the manual completely lie to you, but you have to think through a few pieces of it. There's nothing wrong with this, but the highly detailed beginning can lull you into a false sense of safety. For instance, in the early stages you are warned not to solder a connection yet, because other pieces will also be going to that point. Much later, no such warnings are proffered and you're pretty much on your own for reading ahead to get a sense of where things might pile up. I would say to use caution about soldering things on the terminal strip that runs between the two 300B bases.

It took me almost exactly as long to build the AN as the AES: 16 hours over two days. Again, a photo of the guts of a completed amp would be most helpful.[6] I've got a pretty good idea that the insides of my amp could have been done considerably more neatly than mine were. Having a role model is always nice.

KIT ONE SOUND

No jokes this time. The Audio Note COMPLETELY SMOKES the SE-1. From the moment I turned it on I was drawn into the music, hauling out CD after CD just to see if the spell would break. It gave me all the super-fi thrills of enormously detailed yet thoroughly relaxed sound that I was hoping to get from an SE amp. The AN is still bested by the Fi 2A3 for its ability to see into the music and reveal every sparkling little detail. But the AN comes close, is way smoother, AND it will drive my speakers!

After my experiences with the caps in the AES I was afraid that there was an SE conundrum: either it's smooth or it's detailed and never the twain will meet for drinks, have sex, and assume a mortgage at 6%. Not so. The Kit One is about as nicely balanced a bag of tricks as I've heard, presenting each and every musical thread, but never losing the sense of the music being of a piece. This ain't easy and I've never heard music in my place as pleasingly integrated. The soundstage was wide and moderately deep. Sonic images were thoroughly resolved in 3-D space, every cymbal's slightest shimmer was faithfully reproduced, vocalists seemed fully rendered, guitar sounded like guitar, blah blah blah. I liked it and never wanted to turn it off. Honest. I've been late to work every day and subsisting on about four hours sleep a night since I finished building the kit.

This lively character is what I really love about this amp. No matter how much dough I spend on building my system, Jimi still ain't coming back, ya' know what I mean? The Jimi experience I get to have is playing his recordings, and the hi-fi I want to own is the one that gives the most LIFE to those recordings, while not lying to me about what's on there in the first place. And that's the rub. I don't want any obscuring, no frequency tilts that sound musical but actually hide music, no compression that makes the edges easier to take but just hides the real swing of the music, no overly smoothed tube sound that obliterates spatial detail, no faked up overly deep soundstage. I think the AN comes up like a rose on all these fronts.

After some very close listening and a day of grueling matched level comparisons, I just don't think I'm hearing any less from the AN than I hear from any of the other amps I have around, including a pretty good solid state amp (the Acurus 3X200 I use for surround sound) and my completely excellent Lectron JH-30. And in addition, I believe the AN provides a gripping enjoyability to recorded music that I would characterize as the Single Ended Difference. Listening to the AN you don't think, "Hey, nice hifi," you think, "Cool tunes."

I'm not saying you can do no better than the Kit One. I'm sure you can. I'll even bet that AN will offer an upgrade path. But for the dough, this is a totally pleasurable, involving, ENGAGING amp. What more do you want to know?

CONCLUSION

I got a pretty good sounding amp out of the SE-1 once I chucked the Vitamin Qs and put in Hovland film caps. It won't give you the best possible sound out of a 300B, being kind of weak at both frequency extremes, but it sure is nice through the midrange. It sounds like a good, low power tube amp with classical tube amp failings. As an introduction to both building your own amp and to the smooth, liquid beauty of tubes, it's pretty good. Unfortunately, it lacks the aliveness and immediacy that got me hooked into this whole SE thing in the first place. It is not a major failure, but it doesn't do the trick for me.

The Audio Note, on the other hand, totally thrilled me. It is a MOST engaging amp and gave me real, significant sonic pleasure right out of the gate which hasn't stopped yet. It was not as much fun to build as the AES and less educational because of the PCBs, but for crying out loud, who cares? This is a completely cool amp and I think you would want to own one. It costs almost 50% more than the SE-1, but I'd skip lunch for two months and get the Kit One.

This Just In.. . .Welborne Labs Laurel

Late in the review process I received a prebuilt sample of Welborne Labs $1,700 stereo entry into the 300B kit amp sweepstakes. I didn't build this one, Ron Welborne did, and sneaking a peek into its guts blew my mind. This is what the inside of an amp kit is SUPPOSED to look like! Wow, is it nicely put together! For the first time, I have a real high water mark of craftsmanship to shoot for. Hey, Ron, why not include a picture of your handiwork to inspire kitbuilders? The Laurel is also available assembled at additional cost.[7]

Just on looks, this is the go-ahead winner, fer shur. It is drop dead gorgeous. The AES looks "cute" and the AN like lab equipment, but the Welborne looks like a meticulously restored '66 Jaguar sedan. It comes in a one inch thick walnut chassis, with a brass top plate and unhideous transformers. Really a beauty. It measures 17" across, 14" deep and 8" to the tube tops.

6- Angela Instruments, Audio Note's US kit distributor, includes photos of the wiring of the finished product with the Kit One, printed here for posterity.

7- See further comments on the Laurel and the AES SE-1 elsewhere in this issue.

Like the other kit amps I heard, the Laurel is a 300B SE design putting out about 7 watts. Part selection is first rate, including MagneQuest transformers, Golden Dragon tubes, Kimber and Solen caps, and it ships with both metal film and carbon composition resistors so you can confuse yourself endlessly about which to use. Internal wires are all Kimber and connectors are Cardas.

Along with the amp, Ron sent a preliminary assembly manual. It's way different than the other manuals I used, containing only one page of assembly instructions, but six pages of beautifully rendered CAD drawings showing in admirably clear detail both wiring and component placement. It's a little hard to tell without actually going through the process, but I wouldn't expect this amp to be any more difficult to build than the other two.

I listened to the Laurel on its own for a little while, and I included it in the day long matched levels comparisons with the AES and AN amps. It's a real good sounding amp, much better balanced than the AES with good behavior through almost the entire frequency range, and a reasonably tight, tuneful bass even into the Quads. It's got the SE sound: live, dynamic and detailed yet still smooth 'n' rich. However, for my money, it did not best the AN in what I think is it's best quality: the integration of great transient attack segueing seamlessly into harmonic bloom into decay. In comparison, the Laurel sounded just the littlest bit wiry. I can't help thinking that some Audio Note paper-in-oil caps might shoot the Laurel to the head of the pack, but currently it runs a close #2. For looks, it slaughters the competition.

MANUFACTURERS' COMMENTS

Audio Note

It is always satisfying to see a positive write-up of one of your own products, but what I find particularly satisfying is the fact that here we have yet another convert to the truth that a well executed single ended amplifier is simply a better and more enjoyable communicator of music, regardless of origin and genre. More strength to our hand!

Peter Qvortrup
Audio Note, UK

Audio Electronic Supply

Wow!... two reviews of the same product in the same issue. I am flattered. I must say that I am also pleased to know that single-ended triode amplification is out in the mainstream of music reproduction.

After reading Seth Goldwin's review of the SE-1 amplifier, I must confess that I had a desire in my heart to respond in a fashion unbecoming of a southern "Yankee". I refer specifically to the portion of the review regarding Vitamin Q coupling caps. His suggestion that Audio Electronic Supply "hawks" these caps reveals his illbreeding and inane, witless style of writing. We do not "hawk" anything at AES. We offer legitimate products and parts to the audiophile community.

The SE-1's AC operate and standby switches are made by C&K and are used by millions every year in all types of electronic equipment. These are UL approved flame- and spark-proof switches, but if they are not soldered properly or need multiple resolders because of wiring mistakes, yes, they may become damaged.

In closing I would like to mention that if Mr. Goldwin would like to compare amplifiers that are built and look like fine jewelry, he might look at amplifiers out of the modest price range of the SE-1 ($549 kit form). I should have sent him a pair of Cary CAD-300-SE, or for that matter, a pair of CAD-805 single-ended monoblocks. The Cary amps will smoke anything this boy has listened to or set his eyes upon.

Thank you once again for the opportunity to speak my mind and keep up the great magazine.

Dennis J. Had
President, Cary Audio Design, Inc.

Editor's Note

We were happy to run two articles on the SE-1. It is a landmark product, as all of the current SE kit amps are, and it is definitely worthy of editorial attention. The AES amp is of particular interest to the hobbyist community because of its low price. People seem to be a lot more willing to experiment when the price drops below a thousand bucks!

Designing a $549 (without tubes) amp these days, is no small challenge and the SE-1 strikes me as a valiant attempt. It would be very hard to homebrew an amplifier of equivalent build quality for the money buying parts at retail.

One way to look at this amp, from the hobbyist perspective, is as a starter kit of chassis and iron. Even if you're a novice when you build it, as you learn tube electronics, many options will appear on the horizon. Give the "factory" circuit a listen but realize that there are many possibilities for mods and upgrades to this little amp if you don't like the stock job in your system or you just need a little variety in your life. If a mod turns out to be a mistake, you can always go back to what you had before.

I wouldn't be able to resist giving the 2A3 option a shot if I had the SE-1 and some efficient speakers, say anything that works with a 300B. The 330V B+ supply is perfect for 2A3 or 6A3 tubes, although most users will probably be lured in by the 300B mystique and the few extra watts this tube offers. 300Bs are great, but did you ever wonder why the 2A3 also remains a venerated classic after 60 years? 6A3s with pentode WE 91 style driver stages could be a killer combo in the SE-1 chassis.

The SE-1 could become for triode experimenters what the Dyna has been for p-p pentode guys for decades, a breadboard for all manner of experiments. A couple of tube sockets, transformers, and a power supply can take you in many different directions.

It is always instructive to compare the impressions of two or more listeners to look for some balance, if not consensus. Compare Herb Reichert's comment's on the SE-1 later in this issue with Seth's notes and see if you can make any sense of the big picture. After hearing a dozen or so opinions on the SE-1 varying between "unreal" to "just okay", I'm not sure there is any universal evaluation. Tastes and partnering equipment surely have everything to do with it.

Reviews are often granted significance and authority by readers well beyond their legitimate claims. "Professional" reviewers sometimes go to great pains to qualify, routinize, and objectify their reports but the issue of whether you would agree on good sound if you were sitting on the same bench listening to the same system is a question that the printed word (and Audio Precision graphs) can never answer.

Update: Just borrowed an SE-1 from Mike LaFevre (retrofitted with Magnequest outputs, of course.) Indeed, the overall build quality of the unit exceeded my expectations. All mechanical parts are really nice, especially the E.F. Johnson-style 4 pin sockets. The switches seem fine to me. The neo-designer visuals would probably be considered a plus by most owners unaccustomed to having Frankenstein's lab looking homebrew gear or old industrial amps on the shelf.

I must agree with Seth that the bone stock (except for output transformers) SE-1 sounds slightly muffled. But I recognized one potential cause immediately. Metal film grid stoppers (10K on the schematic) are a chancy proposition but most manufacturers use them without hesitation. Sometimes they sound wickedly bright and sometimes they sound overly dead. Replacing the fancy Dale grid stopper with a good old 1/2 watt "Golden Age of Radio" Allen Bradley composition unit increased the definition and bite of the SE-1 dramatically. A 15 cent Radio Shack carbon resistor would work well also. Appropriate technology for the job, if not glamorous. There you have it: a 30 cent experiment recommended for all amps with metal film grid stoppers. Use ultra-short leads between the resistor body and the tube socket.

Next "mod" is free: for greater "clarity" remove the .22 film cap bypassing the 560 uf 300B filter cap. Some of these compact modern high voltage electrolytics can respond in strange ways when bypassed with certain kinds of caps, so experimentation is required. Haven't figured out exactly why. If the stand-alone electrolytic is too scratchy for you, try a Vitamin Q or something to cool it down. Experiment till you're happy— that's the whole point . . . now where are those 2A3s?

TUNED IN

J.C. MORRISON



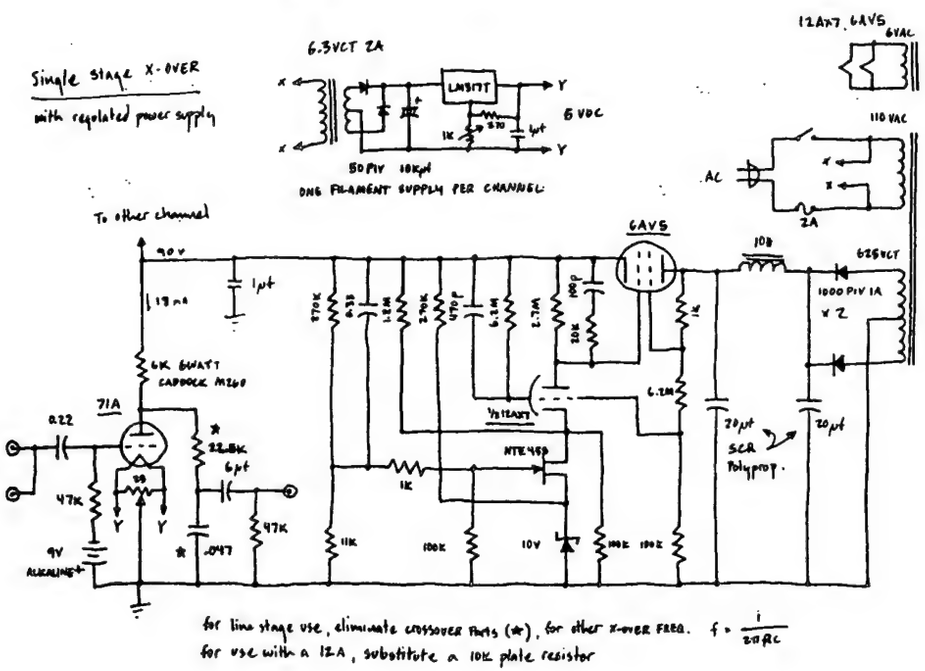
Here's a new arrangement that is really working out great. Running a 301 with a FR-64/DL-103 into a modified Loesch preamp. Then I have this neat bass crossover using a 71A. Digital guys like it minus the network as a CD line stage. I'm looking for a CD player myself right now.

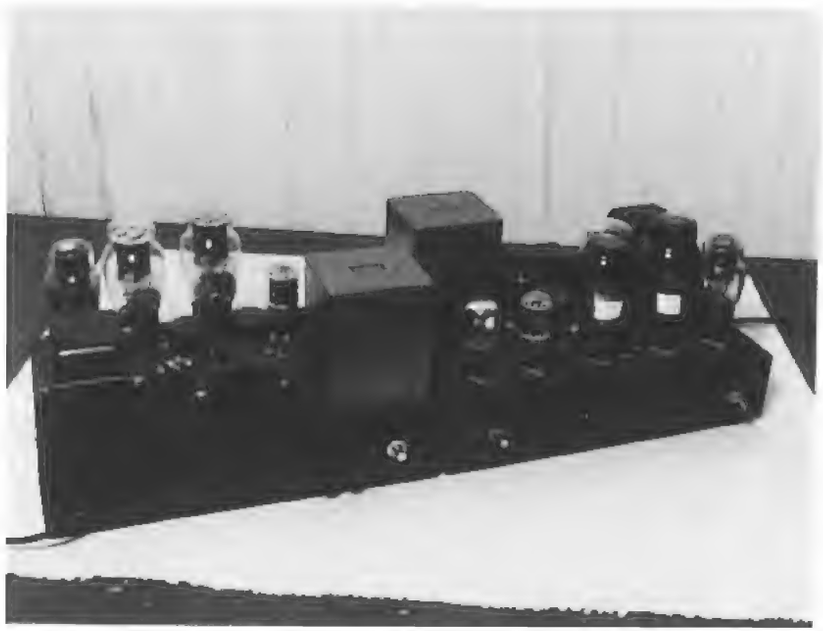
The new Dinosaur is a killer. Works magic on the mids and tweets of my tuned pipe Focal system. Best sound I ever heard from a 50. The Mullard-style push-pull 6B4-G bass sounds alive on a folded tapered pipe.

At 96 dB/1W sensitivity I can play The Melvins with a few triode watts. My friends are jealous. This system smokes on all of my current favorites: the Argo pressing of Britten's "Noye's Fludde," the latest Praxis CD, *Sacrafist*, and a crusty Dinah Washington Mercury I found in the trash off Avenue B.

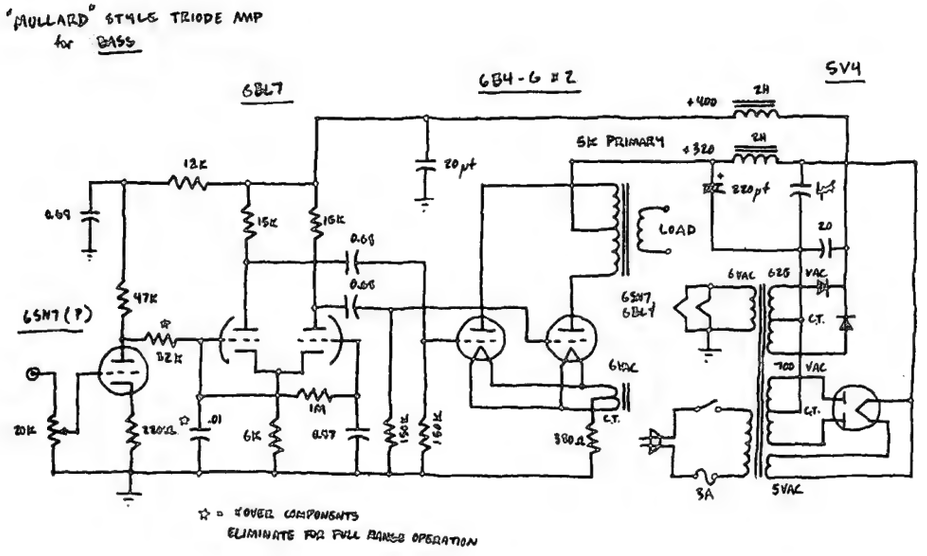
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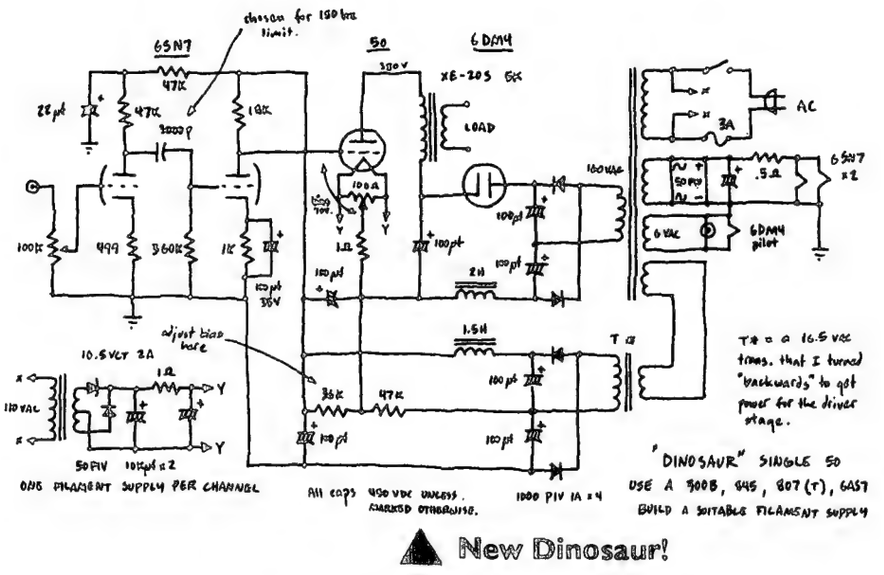
▲ **71A line stage/crossover**





▲ **Mullard-style PP 6B4-G bass amp**





▲ New Dinosaur!



Voigt's formula for a tuned pipe:

$$L_{pipe} = \frac{13548}{4f} - 1.7R$$

where R equals the radius of the pipe and *f* is approximately equal to the resonant frequency of the driver. "Approximately" is where the tweaking comes in.

Be sure to read Weems' 2/87 *Speaker Builder* article if you're interested in pipes.

The crossover inverts phase so I hooked up the bass driver "backwards". A 1 mh choke rolls off the midrange and I use a 4.6 mF cap to bring in the tweeter at around 3K.

	Bass	Mid	Tweeter
	Focal 12V	Focal 7V313	Focal T122Ti
xover freq.	150 Hz LP	1200 Hz LP	3000 Hz HP
tuned freq	28 Hz	100 Hz	600 Hz
pipe length	120"	22"	3"
pipe diameter	13 x 13"	6" i.d. PVC	3" alum pipe
stuffing	wool 30 oz.	wool	wool
port	7 x 10.5"		
cabinet	13 x 34 x 22"		



Tuned In (con't)

I became interested in transmission lines primarily out of frustration with reflex boxes. In my experience, there is a "boing" or "echo" associated with bass reflex that is nearly impossible to get rid of. We all know the lengths some have gone in order to stop transient ringing in vented boxes, "matrix bracing" and the like. I decided to give up instead. Sealed boxes don't ring like that but they have other exaggerated resonances and are generally compressed sounding as well. I looked around at older technology for alternatives. A two-way open baffle sounded great but had limited bass. Later, labyrinth speakers interested me, just as they had caught the interest of many way back in the day.

Lines and pipes are basically loading systems which either dissipate or null the back wave of a speaker driver while providing the high acoustic impedance that cone drivers like to work out of. The advantage of dissipating rather than trying to tune the backwave is simplicity. The driver gets the extra damping and restoring force it needs at the resonant frequency but with less potential for interaction than a resonant box. An additional bonus is that lines and pipes also lower the frequency of those resonances. The mere fact that the box is open makes for a more open and dynamic sound. All told, the most important benefits can be listed as similar to the best vented boxes, but the result is smoother and the problems are more innocuous.

My present speaker system is a three-way transmission line. The drivers I use are made by Focal and are widely available. The basic idea is to use a single-ended amplifier to drive the mid and treble and a push-pull amp on the bass.

The tweeter is a Focal T-122-Ti, an un-chambered version of the T-130 with an oxidized 1" titanium dome. The efficiency is 95 dB/1W@1m. The pole-piece comes drilled with three holes through it so that the unit has as much output from the back as it does from the front. The line is made from 3" o.d. aluminum pipe and it is tuned for 600 Hz, i.e. 3" long. Dimensions are calculated according to Voigt's classic formula given above. A hamburger sized wad of long haired wool is stuffed in the line.

The midrange is a 7" polyglass coated paper cone, the Focal 7V313. It draws heavily on the Lowther PM-2 and the JBL LE5 for its technical heritage. The super light stiff cone, huge magnet, short underhung voice coil, and lossy coated foam surround moves a lot of air and provides shocking transient performance. Its nominal efficiency is 95 dB/1W@1m. I have given up on small midrange drivers. They *all* sound anemic and lifeless to me, no matter how pretty they may be. The other advantage of a 7 or 8 inch mid is that it can usually cover the entire vocal range + harmonics. This means *no crossover between 150 Hz and 3 kHz*, a strangely uncommon practice that can only make for better music. I'd prefer one driver that works from 100 to 10,000, an old QUAD that actually moved air at 100 dB SPL. If only. . .

The midrange works into a 6" i.d. PVC pipe 22 inches long. The line frequency is 100 Hz and it is loosely filled with wool. Like the JBL and Lowther drivers, the Focal has one nagging quirk— a rising output with frequency characteristic that makes for that old bright and in yo' face "West Coast Sound." More on this later.

The woofer is a monster: the Focal 12V. Nominal efficiency is 96 dB/1W@1m. Same "polyglass" coated paper cone as the midrange, which makes for a seamless match. The 3" voice coil is vented through the rear of the driver. A coated linen accordion surround damps the cone. As with the 7V midrange, a huge magnet and a short underhung voice coil provide wild dynamic shifts if they come up. The 12V works into a 10 ft. line folded into a box 13 X 32 X 22" with 30 oz. of wool distributed through the line.

The midrange and tweeter are crossed over with a first order xover, the only kind I use anymore. The trick with the 7V is to cross it over early (1200 Hz in this case) to minimize the effects of the rising amplitude characteristic. The tweeter needs to be cut at least two octaves above resonance (3000 Hz) to really work well with a first order crossover. I actually spread it a little to get a small "Advent dip" in the presence region.

The bass amps are standard Mullard type circuits with self-biased 6B4-Gs in a push-pull no feedback configuration. I parallel a 6SN7 and directly couple the plate to a 6BL7 long tailed pair. There are no sneaky tricks, just a low impedance driver stage and the tactic of burning the tubes at 17W dissipation (272 V X .126A = 17.13 W). I use an RC filter between the direct coupled stages to roll off the highs above 500 Hz, well out of band of my intended 150 Hz crossover.

The active crossover is a single 71A triode gain stage with an RC filter tuned for 150 Hz. Without the RC network, this unit makes a great line stage project for those of you who must own a CD player. It may almost sound like music after a trip through a 71A. Other little triodes that lend themselves to this type of circuit are 12-As and 26s. These little tubes with solid nickel plates are super detailed and hyper beautiful.

The "Dinosaur" has been changed several more times since the last article and I am even happier with it. It now dispenses with the FET and the cathode follower, although I must confess a growing interest in FETs (cool sound). I had three directly coupled tube stages, but now I use a small cap between the first and second stage to limit the bandwidth to 150 Hz high pass.

The cables are all Kimber Silver, which should be a controlled substance. The phono preamp is a stealth device I worked on with Art Loesch. The attenuator is an Eltus, an expensive Japanese 'L' pad, 250K with 47K Holcos paralleled to the I/O. The turntable is a 301 with a Fidelity Research FR-64 arm and a new model Denon DL-103 moving coil. I have to make new arm cables as the ones I'm using are shot.

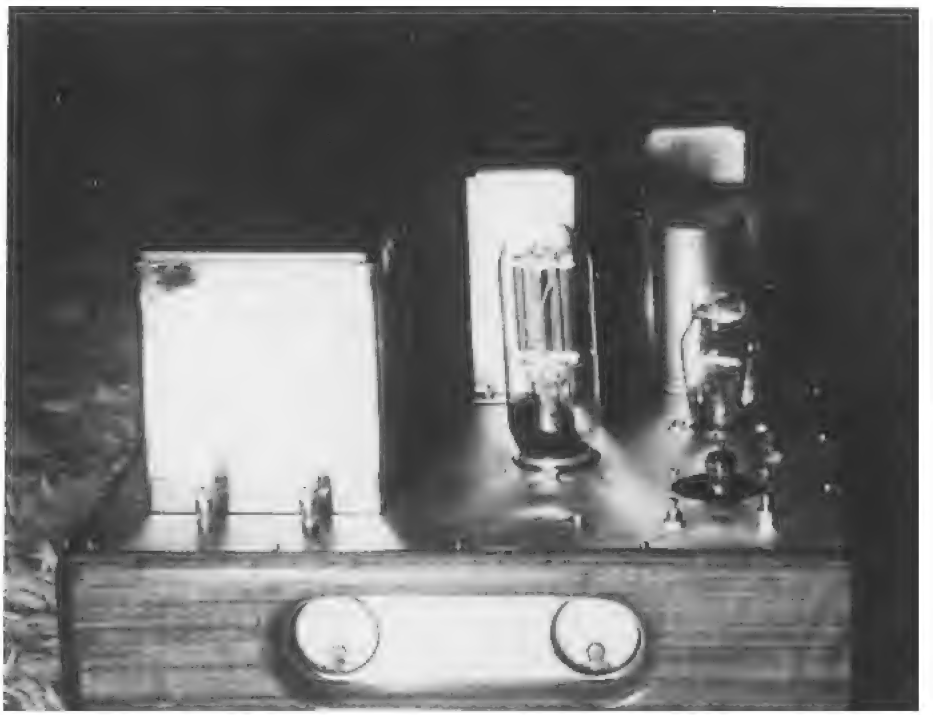
I also use a heavily modified Thorens TD-124 with a Sumiko FT-3K arm and a Stanton 981LZS low impedance moving magnet. If you are looking for a cartridge, please check this one out. Not only is the general presentation big and present, the subtle stuff around and behind the music is there in delightful proportion. I am shocked at how stupid good this cartridge sounds. I think it is impossible to get more phono music for the money.

All this stuff *plays* my records and I've been having big fun with the bass, which goes all the way down. Splitting the work up between top and bottom simplifies matters dramatically. There is a myth that one amp is somehow more "zen" or something. Unless you are driving one speaker, this is absolute crap. Two drivers and a passive crossover with one amp, especially if it is a multi-pole crossover, is more of a liability than using two amps. Single ended technology doesn't make much power and will cramp the style of many modern speakers. This can be heavily compensated for by limiting the work an amp has to do. Given the efficiency of any speaker, 66% of the power needed for audio occurs below 150 Hz. The increasing availability of drivers in the 90-96 dB range means that integrating these low power amps is not beyond anyone's reach. Make your own and bi-amp!

ORFEO 211 A

OR HOW TO BUILD SOME SINGLE TRIODE AMPLIFIERS AS BIG AS AIRCRAFT CARRIERS (WELL, ALMOST) AND LIVE HAPPILY EVER AFTER LISTENING TO THEM

by Ciro Marzio and Cristiano Jelasi



Part I: Overview and Power Supply Considerations

The Orfeo is clearly intended to be a definitive amplifier. Its musicality is truly resounding, just like that of the mythical singer to whom we have dedicated it.[1] Commercial amplifiers that can aspire be its equal are truly few, extremely few, or maybe even fewer than that! While it is true that audiophiles who undertake this project will find themselves faced with a rather demanding task, they will be repaid with the attainment of a musical pleasure that will last for years. In other words, the Orfeo can be a steady focal point around which the rest of your system can develop and evolve.

This amplifier was redesigned several times and this last version is decidedly simpler— and more musical — than its predecessors. This progress, however, has been paid for with an degree of encumbrance and weight that is truly extraordinary: each amp we built weighs nearly 55 kg and measures 85 cm x 45 cm x 30 cm. If you have problems with limited space, this is not the amplifier for you!

1 — When we first built the prototype of this amplifier a few years ago, there were no commercial products of the same name. Since then, more than one "Orfeo" has appeared, and we wondered whether to give ours a new name or not. In the end we decided to keep its name: it has plenty of personality to distinguish it from any other amp.

And while we mentioned that the circuit topology of the amp is relatively simple, we must recommend it only to hobbyists who already have extensive experience with tubes. The voltages in play are very high (over 1200 volts !!) which is why this is NOT the circuit on which to make your bones! We caution even expert hobbyists to exercise maximum prudence. At these voltages, any carelessness can be fatal. In addition, take every possible precaution to safeguard all persons who may find themselves, even if only occasionally, in contact with these amps. Having made this dutiful introduction, we can go on to the description of the amplifier.

Design Philosophy and Goals

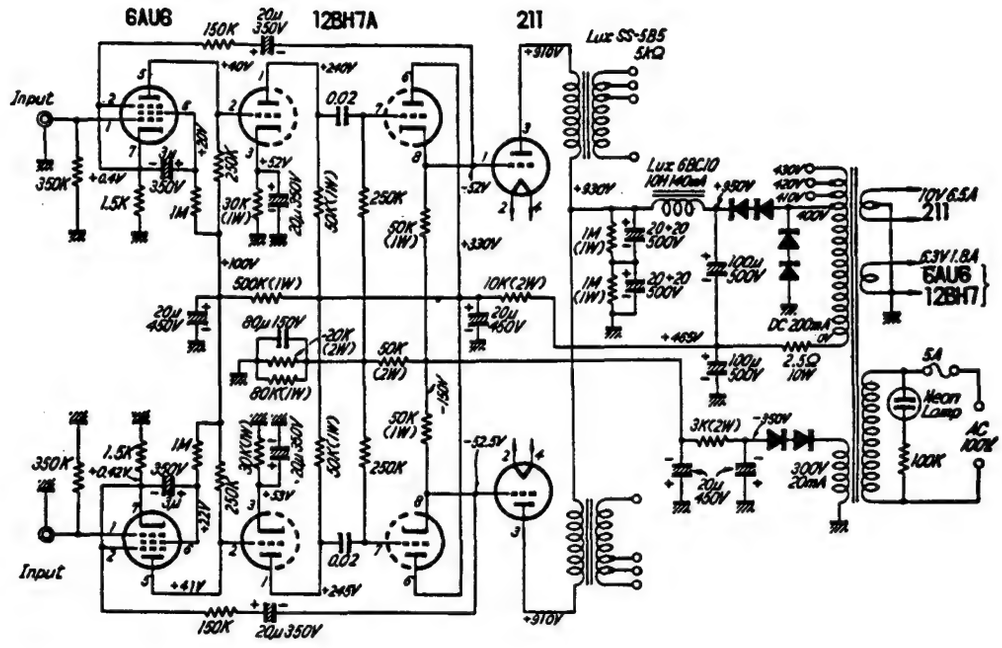
The principal criteria guiding the design of this amplifier are maximum simplicity and circuit linearity, in the belief that all that which is not present in the signal path cannot deteriorate it. (Remember Ford II's maxim that anything that's not there, in a car as in any other piece of machinery, cannot get broken.) Obviously, this philosophy has positive effects on reliability as well.

The Orfeo is a three stage circuit capable of output power of circa twenty watts. Each stage is single ended using pure triodes. This choice is quite unusual, yet we are convinced that the principal reason for the superiority of single ended resides in the fact that the circuits making use of more than one tube in the same stage suffer due to the inevitable differences present between one tube and another. As is our custom, there is no negative feedback.

The power supply was the object of particular attention. We conducted long listening tests of various prototypes using different supply configurations. The goal was to verify eventual listening differences between regulated supplies, unregulated supplies with inductive input filters, and unregulated supplies with capacitive input filters.

With respect to circuit evaluation, we took into account both listening results and test results, but we privileged the former in all cases where the results of the two methods differed. In our view, the ultimate goal of any piece of hi-fi equipment is that of making one listen to good music and to transmit the emotions that are part of the music. Musicality is therefore always the principal parameter we use to evaluate our amplifiers. Even when choosing among different types of circuits the definitive judgment is far

1971 Uesugi circuit



more influenced by listening than by technical performance. This stance sometimes leads us to adopt solutions that, based on theoretical calculations alone, may seem unorthodox to some readers.

In the selection of materials we tried to reach the best compromise possible between the desired listening results and costs. Although this is not a project in the "cost no object" category, it is nevertheless requires a somewhat substantial investment. Our goal is music reproduction instruments of absolute top rank so we were willing to commit resources in order to get where we wanted to go.

A secondary effect, sometimes listed first, of our no-compromise design goals is the decidedly extraordinary size and general unwieldy form of the Orfeo. We admit not making particular efforts to contain the dimensions in as much as that would have been possible only to the detriment of quality or a further increase in costs.

The Power Supply

That the power supply is as critical to sound as the amplifier circuit proper is not a new assertion. Every builder of esoteric amplifiers believes in and celebrates the miraculous qualities of the supplies used in his own equipment. Still, in the great majority of commercially produced amps, the compromises are many, despite high sounding declarations. This is inevitable for two basic reasons: a good supply is necessarily expensive and also necessarily cumbersome.

In the case of the 211, and its close relative the 845, there is also the problem of high voltage requirements in the plate supply. Let's see how some of the most famous circuits resolved this problem. Not surprisingly, these are all Japanese designs.[2]

During the long development process of this project, we closely studied the "classic" 211 and 845 circuits. We built and listened to examples of those power supply solutions which seemed most promising, using components that we preferred in our own amplifiers. These circuits served as guideposts in our development efforts. We considered humility in the face of designs of the past a

2— ed.- Although these triode amp designs (and their creators) are recognized in Japan, their "classic" status in the Western world largely results from their appearance in Jean Hiraga's seminal publication *Initiation aux amplis à tubes*. (Editions Fréquences, Paris. ISSN 0753-7409.) This historical survey provided the Western world with an introduction to the Japanese tube audiomania experimenter scene and certainly ranks among the most influential specialist publications of the modern vacuum tube era.



Side view of battleship Orfeo

necessary attitude for those preparing to build amplifiers intended to surpass the classics. At the same time, we argue that it is always necessary to verify improvements through actual listening tests.

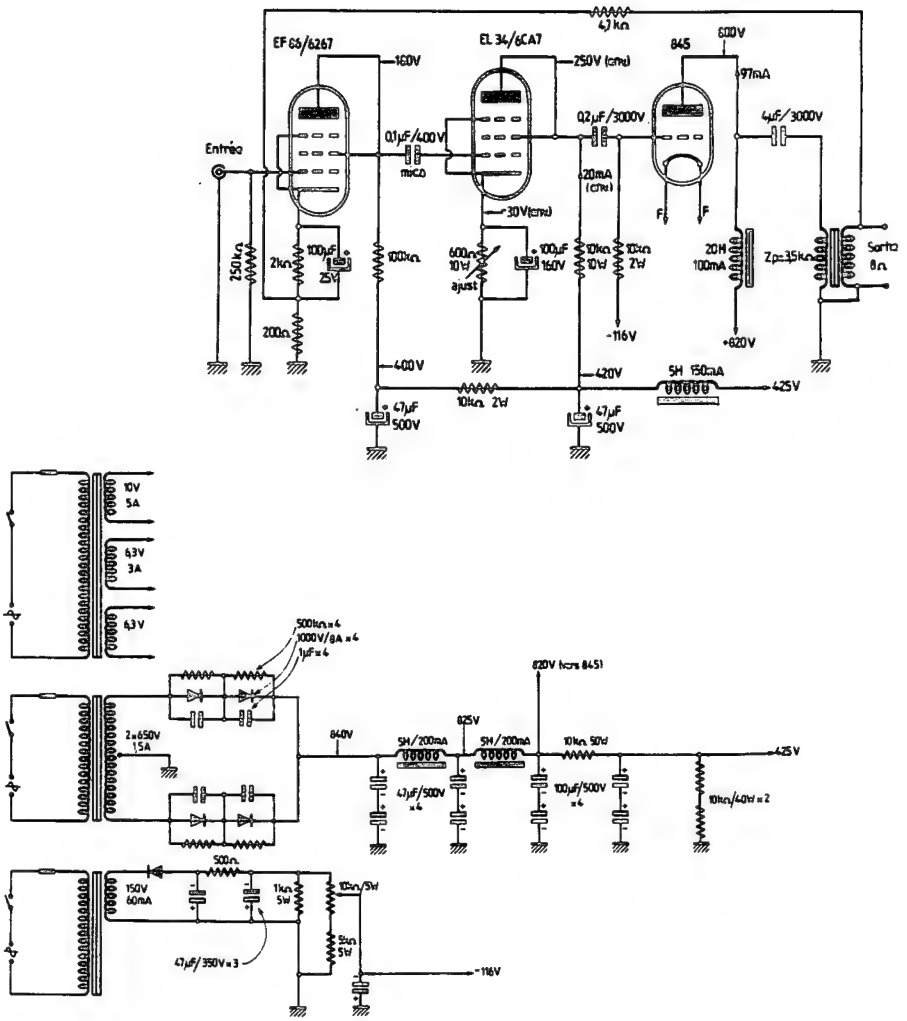
We begin with the legendary 1971 Uesugi design. Mr. Uesugi is a living legend in the Japanese scene. His amplifiers are considered to be products of exceptional musicality by discerning Japanese audiophiles. Among these, the most famous is surely the large 211A mono amp, which can also use the 845. These amps are still in production on a built on demand basis. They have never been imported in Italy.

The Uesugi is a four stage 15 watt amp with a 6AU6 pentode in the first stage, one section of 12BH7 in the second and third stages, and a 211 final. The plate supply uses a voltage doubler with solid state diodes. In this supply there are two voltage take off points. The first provides 900 volts to a pi-filter using a 10 H choke, the other one furnishes about half that voltage to a separate C-R-C filter which feeds the first three stages of the amplifier. Another winding on the transformer provides the grid bias supply. The version we are discussing uses one power supply shared between channels but there is also a version of this amplifier which is completely dual mono.

Another more involved approach was also launched in 1971 by Atarashi in his 845 amp which can also use 211s with some loss in power output. He used three different transformers for filament, grid, and plate supplies. The B+ current is extensively filtered in the purest "audiophile" style. First there is a double pi filter (C-L-C-L-C) then a section of RC filter voltage dropping, then an LC stage to feed the triode wired EL34 driver. Finally there is an RC filter feeding a triode wired EF-86 input stage. The three chokes are all five Henry units. The ripple reduction factor of this supply is very good, especially in the first two stages. The improvement of this approach over that of Uesugi's approach is clearly audible.

Next, we will look at a much more recent amplifier, the Audio Note *Ongaku* (as published in *SP* #2). This stereo amp is available in Italy and it is very famous, mainly for its stratospheric cost. The stated output power is between 23-27 watts but this specification seems somewhat optimistic.

The *Ongaku* plate supply uses two secondaries of the supply trans. One of the windings supplies the first and third stages of the amplifier and supplies grid voltage to the 211. The other provides B+ through solid state rectifiers to a double section cap input filter. The center-tapped secondary feeds the second and last stage through a full wave bridge using 5AR4/GZ34 tube rectifiers. The hybrid approach of using both solid state and tube rectifiers is perplexing. The bridge rectifier feeds a cap input supply using a rather low inductance value of 3 H.



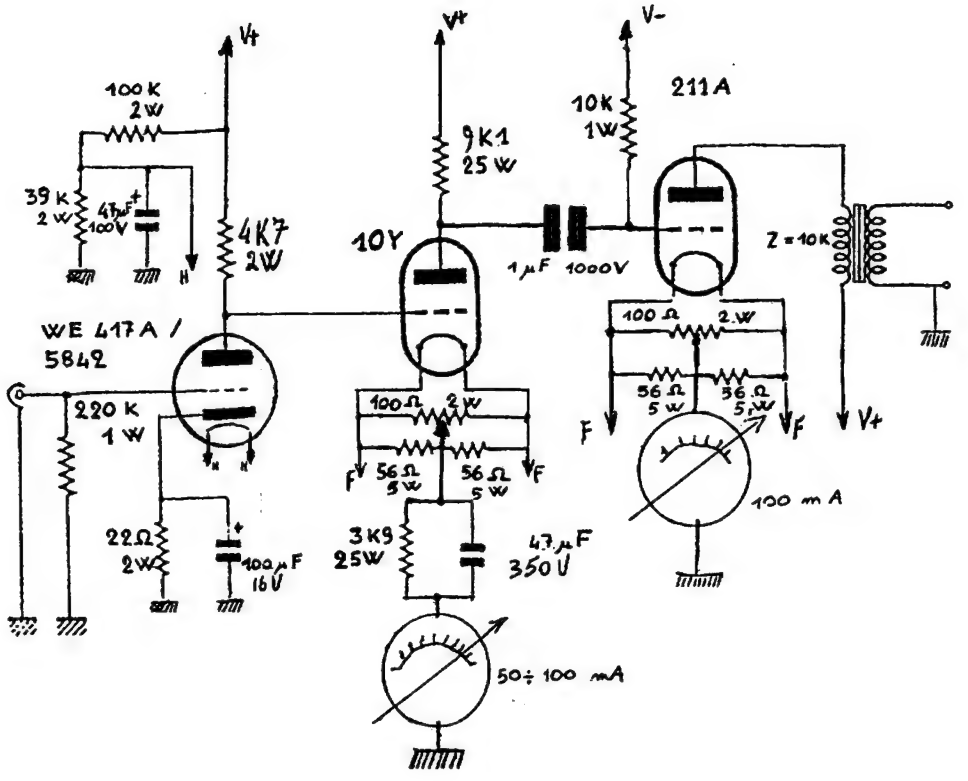
1971 Atarashi circuit

Our Plate Supply

We based our supply on the results of long comparative listening tests using regulated and non-regulated supplies. Each of the three stages has a dedicated supply using a single transformer with three separate windings. We preferred vacuum tube diodes to solid state diodes, even though they are more expensive and cumbersome because of size and filament supply requirements. However, in listening tests they were more musical over almost the entire audio band than solid state devices. This was no area for compromise.

The first two stages have full wave rectifiers using dual diode rectifier tubes. The final stage uses a full wave bridge rectifier, using four dual diodes mounted in parallel. Someone will surely object that this rectification scheme costs decidedly more than a full-wave rectifier, but keep in mind that it considerably simplifies construction and reduces initial cost of the supply transformer since the transformer must supply less voltage using a full-wave rectifier circuit.

Another consideration is that vacuum diodes are much more durable than silicon full wave bridges. Considering the high B+ voltage and its associated problems this solution seemed preferable to us. The plate voltage comes off the center tap of the filament secondary winding which adds a slight reduction in ripple.



AUDIO CIRCUIT PARTS LIST

Capacitors

C1	100uF	16 Volt
C2	47uF	350V
C3	1uF	1000V
C4	47uF	100V

Resistors

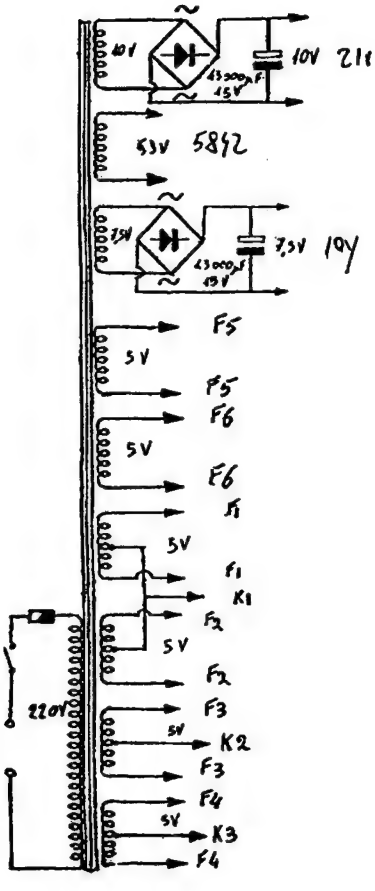
R1	100K—220K	1W
R2	22—27Ω	2W
R3	4.7K	2W
R4	3.9K	2W
R5	9.1K	20W
R6	100Ω	2W wirewound pot
R7	56Ω	2W
R8	56Ω	2W
R9	12K	1W
R10	100Ω	2W wirewound pot
R11	56Ω	2W
R12	56Ω	2W
R13	100K	2W
R14	39K	2W

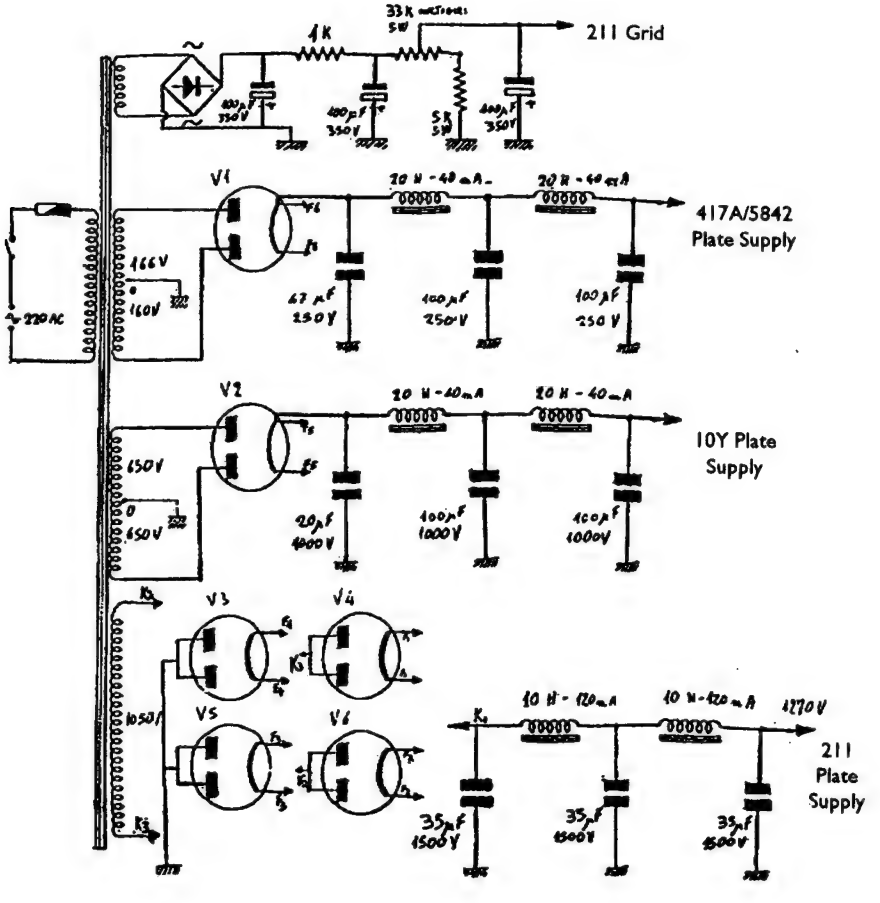
Tubes

V1	417A/5842
V2	10Y/VT-25 or 801A

Meters

G1	50mA
G2	100mA







The filter for all stages is of the capacitor input, pi filter type using high value inductors and capacitors. The first two stages have an input capacitor of a relatively small value (22 uf) followed by a 20 H inductor with a high value cap (140 uf) then another 20 H inductance and finally another 140 uf cap.

POWER SUPPLY PARTS LIST

Capacitors

C1-C2	43,000 uF 15V electrolytic
C3-C5	100uF 350V electrolytic
C6	47uF 250V film
C7-C8	100uF 250V film
C9	20uF 1KV paper in oil
C10-C11	100uF 1KV paper in oil or film
C12-C14	35uF 1500V paper in oil

Chokes

L1-L4	20 Henry 50 mA
L5-L6	15 Henry 140 mA

Resistors

R1	1K 2W
R2	33K 5W
R3	5K 5W

Solid state diodes

PD1	150V 25A
PD2	150V 15A
PD3	600V 5A

Rectifier Tubes

V1	5R4GY; 5R4WGY; 5V3; 5V4; 5U4G; 83V; 80; GZ33; GZ37; 5Y3; 6087; U52
V2	5R4GY; 5R4WGY; 5R4WGA/B
V3-V6	5R4GY; 5R4WGY; 5R4 WGA/B; GZ37; 5V3; 5U4G; AZ50; U52

5R4WGB stack ← Capacitor bank →

The filter of the final stage uses three 30 uf capacitors and two 15 Henry inductors.

Remember that the energy stored in a capacitor is proportional to the square of the voltage.[3] Therefore, the energy storage of a small cap at high voltage can approach or surpass that of a large cap at low voltage. Hence, a 140 uf cap at 650 volts has an energy storage of around 30 Joules. A 35 uf cap at 1250 V stores 27 Joules. The current required by the output stage is relatively high so chokes of adequate current handling capability above 15 Henries would quickly become enormous. With the inductance values we use, the ripple is sufficiently low such that it is not worth worrying about.

The dimensions of the group of three plate supplies is, as you can imagine, anything but compact — but it is definitely worth the effort! The improved listening results with such an elaborate supply justify the expenditure of resources.

Filament Supply

All the filaments of the rectifier tubes are supplied AC by secondaries of the filament transformer. We found that AC heater supplies do not cause audible hum with indirectly heated tubes. Even the input tube is heated by AC with a dedicated winding. We tested a regulated DC filament supply but it did not provide audible benefits, therefore it seemed reasonable to opt for the simpler solution.

On the other hand, hum problems *are* prevalent with directly heated tubes, hence the driver and output tube heaters are fed with DC to reduce hum problems. We use a simple full wave bridge supply with a large 43,000 uf cap. It is important to make sure that the actual filament voltage *under load* is close to nominal. Insufficient voltage causes an audible deterioration in the sonic presentation of the tube. Overvoltage notably shortens the lifespan of the device.

On the schematic you will find that the values of the secondaries are slightly high. We did this because it is necessary to consider a high voltage drop through the power supply components. Depending on the DC resistance of your chosen inductors, it might be necessary to use dropping resistors calculated according to Ohm's law to adjust output voltages to the nominal value.



Negative grid supply

The dedicated grid supply for the 211 final is, in essence, rather simple. Like the other supplies it is not regulated. Contrary to what one might expect, we found that a regulated grid supply caused a *greater* effective variation in the plate current than an unregulated grid supply. This is because if the grid supply is kept totally independent of the plate supply by regulation, fluctuations in the plate voltage are not accompanied by corresponding variations in the grid supply. An absolutely rigid bias supply, then, does not provide more stable operating conditions when an unregulated plate supply is used.

The circuit description is simple— the voltages are supplied by a dedicated secondary of the transformer, rectified by a solid state bridge.

It is possible to use tube rectifiers in the bias supplies, but we didn't find that it is of particular sonic benefit in this case, so it was not worth the extra effort. Note that the polarity of the rectifier is inverted because we need to obtain a negative voltage. Filtering is via a C-R-C filter, two 100 uf caps with a 1K resistor. A 33K potentiometer is connected to ground through a 5K resistor and it is from the wiper of the pot that the negative voltage is picked off. The voltage can be adjusted with the pot.

3— The formula for calculating the amount of energy stored in a capacitor, expressed in Joules is: $E=C \times V^2/2$

Components
The biggest challenge in building a musical amplifier is the challenge of finding capacitors adequate to your ambitions. Capacitors in the power supply affect the sound of the amplifier as much or more than the rectifier tubes. We immediately eliminated electrolytic capacitors from consideration. There are multiple reasons for this decision:

a) They are not sufficiently reliable. It is not unusual to find electrolytic caps that cannot withstand rated voltage and they are vulnerable to peaks of short duration. In view of the voltages in use in this amp, it is not worth the risk.

b) Electrolytic caps rated at high voltages are a rarity. In practice, the DIYer must series several capacitors to achieve adequately high rating, outweighing any space-saving advantages that electrolytic caps offer in contrast to non polarized capacitors.

c) The musical performance of electrolytic capacitors is not exactly outstanding, so we say just forget them.

DIYers can at this point choose whether to begin a search of flea markets and surplus stores for good old oil caps or turn to current production film capacitors. There are even film in oil caps. For high voltage use, as in our 211 amplifier, the oil type intended for this service would be preferable. In Italy, such caps are produced by ICAR and ARCOTRONIC.

Of course, all of the filter caps are bypassed with high quality small value caps. We have had good results mixing capacitors with different dielectrics, e.g. 35 uf paper and oil, paralleled with a .22 uf polystyrene and a 5000 pf silver mica.

Wire
We recommend silver plated OFC or solid silver, possibly Teflon insulated. Watch the insulation rating carefully. If you are not completely certain that the insulation is more than adequate, get yourself some teflon tubing to reinforce the insulation. Take care to separate any non-insulated high voltage points from ground to avoid arcing. Always leave enough room between one conductor and another. Back when we were building the prototypes, a resistor opened while we were listening one day but the unit continued to play thanks to a voltage arc across the terminals which completed the circuit!! In short, take every imaginable precaution in the interest of safety when building or working with high voltage equipment.

Inductors and Transformers
This amp will require specialized transformers.[4] It is possible to build it with surplus components but keep in mind that the size and weight will increase beyond the already substantial mass of our amplifier due to the number of filament and plate windings required. In any event, be sure that the high voltage terminals are adequately spaced and well insulated. Suitable filter chokes can be found on the surplus market with a bit of dedication, but to us it seems simpler to let your trusty transformer supplier wind them.

Rectifier tubes
We prefer the 5R4W, ruggedized military version of the 5R4, which are very beautiful aside from working very well. You can happily use a standard 5R4, which has a lower voltage rating than the 5R4W but still has a high margin of safety in this application. You can also use the following tubes in your bridge rectifier: 5V3, 5U4, U-52, GZ-33, GZ-37, or AZ-50. Each sounds slightly different and the choice is largely a question of taste. Keep in mind that these tubes are not adequate for the driver stage supply since the voltage exceeds safe operating range. There, the 5R4 is an almost obligatory choice.

The input supply operates at a considerably lower voltage than the other two and there are many usable rectifier tubes. To conclude, we recommend that you use ceramic base sockets of the best quality for the rectifier tubes. They will need to withstand high temperatures which can be a problem with bakelite or, worse yet, plastic sockets.

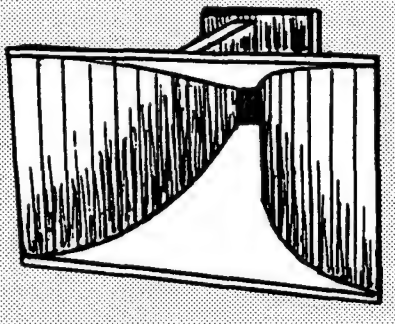
Part II
We will continue our discussion of the design and construction of the Orfeo 211 amplifier next issue with an examination of the audio circuitry.

The original version of this article was published in the Italian-language DIY journal *Costruire Hi-Fi: Rivista per autocostruttori di sistemi audio diretta da Paolo Vippiani.* Issue 8 (Feb. 1994) and Issue 9 (April 1994).

4— Elettrica Brenta can supply a complete set of transformers and inductors for this amplifier at an approximate cost of $1400 US for the set. For more info contact: Elettrica Brenta, Vic. Vespucci 5, Fiesso D'Artico, Italy. (39)41-5161552 phone and fax.

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HIDOTRAC

A TURBO CLASS A PUSH PULL 2A3 AMP

BY DIEGO NARDI

At the tender age of 25, I am privileged to qualify as a "tube electronics professional," an unusual occupation for a member of my generation. At the moment, my job is repairing, designing, and modifying audio gear, my specialty being tube amplification, of course. Presently, I am the official service technician for Audio Note Japan and UK products in the Italian market.

Much of my audio education comes from working on and listening to a wide variety of contemporary and classic equipment, including some top of the line Audio Note products which I have been fortunate enough to live with from time to time. At present, my home system is powered by self-designed, home-bred, no-feedback triode amplification. What I'm introducing to you here is a line integrated, 2A3 based push-pull amp that I built for purposes of experimentation and which I liked enough to retain as the main amplifier in my system.

Despite its rather complicated structure — five stages in the main circuit plus a cathode follower tape out, two power transformers for five independent power supplies — this amplifier is no big thing and a standard 44 x 35 cm chassis is enough to contain it all.

This prototype contains a few fine components I secured from Audio Note including a couple of small Black Gate electrolytics, four Jensen paper-in-oil coupling caps, and a piece of AN-V silver interconnect to give the final touch to sound quality. For the most part, however, components were standard industrial grade items. I wanted to see what kind of performance I could obtain without relying on special ultra high grade/expensive parts.

Transformers were made by my transformer supplier specifically for this amp. The outputs are fine special alloy 0.1mm lamination double-C cores, a Williamson-like 18 section winding, yielding an excellent 16-155,000 Hz response between -3dB points at 1W and a 25-45,000 Hz full power bandwidth (with two clean Watts still available at 140,000 Hz) and modest losses. All of this with no feedback at all.

There are a couple of technical solutions that are quite unusual, at least for the way they're used. The first one is that phase inversion is obtained by means of a low-impedance interstage transformer (also C-cored) splitting the amp into two parts. At the left of the phase splitter transformer, an SRPP/cathode follower direct coupled stage acts as a very linear line amplifier. This driver combination not only amplifies the incoming signal but it also provides a nice low impedance source to drive the transformer primary. Because the interstage transformer is a low inductance unit, a low impedance driver is necessary for good LF response.



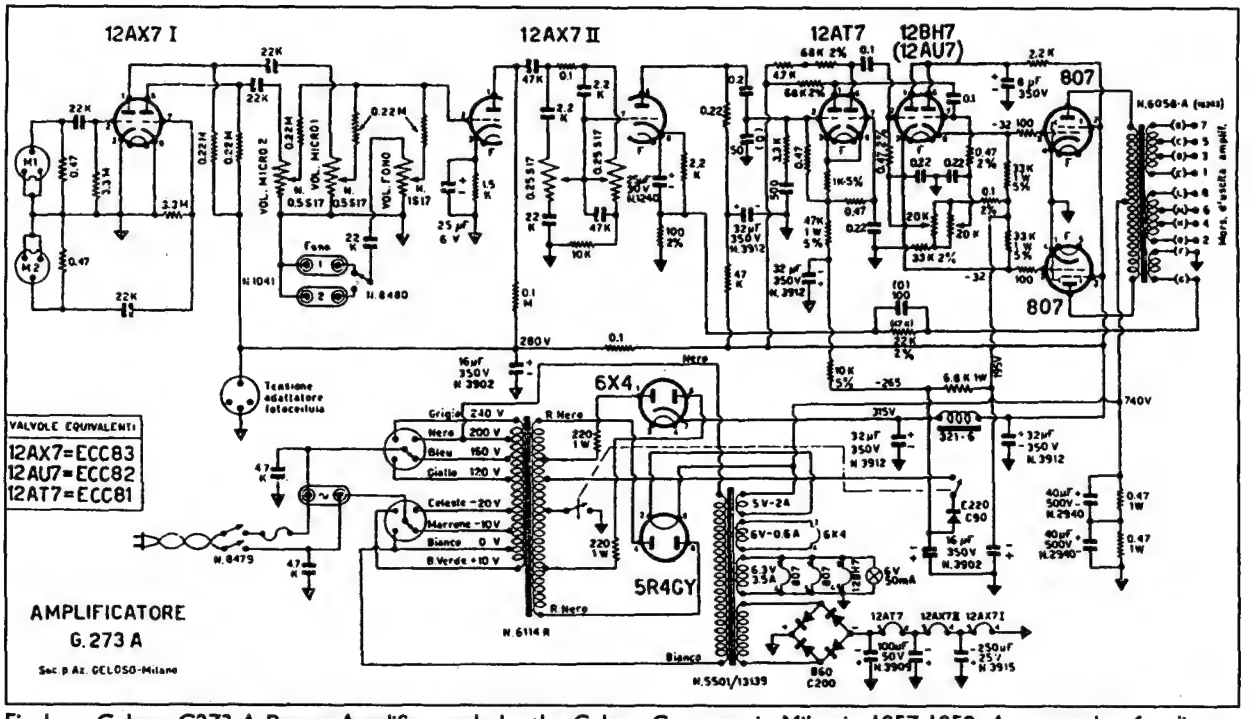


Fig 1 — Geloso G273-A Power Amplifier made by the Geloso Company in Milan in 1957-1959. An example of a direct coupled cathode follower driver in a class AB2 high power unit, this amp could produce 100W from a pair of 807s. Although intended for PA applications, it is a basically sound design that could be developed into a respectable hi-fi amp.

The use of a transformer for phase inversion is the point from which the whole project originated. Whatever this amp was all about, it had to have a transformer phase inverter. I wanted to do without electronic phase splitters with their problems of non-symmetrical output impedance and non-symmetrical distortion.

My transformer supplier already had a suitable unit in current production, intended for use in balanced lines in PA equipment. For reasons of economy, I decided to give what was available a try rather than having a custom made unit produced.

Design of traditional interstage transformers is critical in that they are meant to work exactly as output transformers, using their primary as a load for a single ended stage and their secondary feeding the output tube grids, usually with a step-up ratio. With this arrangement, the plate current of the driver tube passes through the primary and (this is a big "and") the grid current of the output tubes passes through the secondary. The input capacitance of the output stage also poses a challenge to the driver.

These requirements call for:

1 — High primary inductance and gapped core, therefore lots of turns on a big core.

2 — Extremely low leakage reactance, not only to get good HF performance but also to avoid oscillations that can easily occurdue to the output tubes' input capacitance if the two halves of the secondary are not very tightly coupled.

Getting reasonable performance from such a transformer would require something big and expensive. I wanted something small and cheap!

A different approach was obviously needed. I took the following steps:

1 — Moved the transformer to a point where it has to work at a low level (hundreds of millivolts not hundreds of volts).

2 — No DC through the transformer.

3 — Made provisions for a constant low impedance point within the amp to install the transformer.

This approach allowed me to specify a slightly modified version of the tiny PA unit mentioned above. It weighs only 150 grams potted and it is no bigger than a 2 uF coupling cap. My arrangement is unusual in that the tranny is driven by a cathode follower with parallel feed and it has a 2.6:1 step-down ratio (input to either output). It is directly connected to the grids of the voltage amplifier stage and therefore acts as a very low value grid leak resistor. This way, the VA stage sees a 30 ohm impedance and the line stage sees virtually no load at all.

Response of the driver stage is flat and in phase from 20 Hz to 40,000 Hz, some very slight ripple to 60,000 Hz, and then flat and in phase again out to over 200,000 Hz.

The line stage is coupled with the primary through a Solen capacitor. This type of coupling results in a second order RLC series high pass filter which provides the amplifier's main pole at low frequency. This arrangement effectively stops any subsonic signals that might bother the subsequent stages. You might get more very low frequency phase shift with this arrangement, but you'll save your output stage from wasting energy swinging your woofer back and forth while you're playing a warped record. This amp is not a power plant! You want to use its power to play music, not record warps.

Looking at the schematic, to the right of the transformer you find something like a "two and a half" stage amp which is push pull throughout. There is a balanced differential voltage amplifier, RC coupled to two cathode followers hanging on to a dual power supply. Each of them in turn feeds an output tube.

This type of driver is not very frequently used in commercial hi-fi amps. I saw it in several exotic single-ended designs from Japan including the Audio Note Japan SE amps. The cathode follower driver historically was most often used in push pull amps in which the output stage was deeply biased in Class AB2. Have a look at the Brook 10C schematic from *SP#2* or the mid-50's Geloso PA amp from Italy (Fig. 1) which pulled 100W out of a pair of AB2 807s.

The strange thing with my amp is that it is Class A. Let me explain my reasons for driving a Class A PP amp this way. Basically, I disagree with the thinking that because a low power Class A amp is not intended to run into the grid current region, only a textbook voltage amplifier is needed to drive the output stage. I base my position on looking at the actual behavior of many amplifiers using many different driver/inverter circuits. They work fine when the output tubes are not driven hard, but they simply lose control of the grid when the amp is stressed in the slightest degree.

Moreover, when you have a triode at the output, its input capacitance due to Miller effect is very considerable — 150 pF or even more is quite normal in a hot 2A3. A plate loaded triode or, to a lesser extent, an SRPP driver will generally show quite poor slew-rate performance and somewhat high distortion with such a load, well before the output tube begins drawing grid current. What you get is a loosely controlled, slow output stage whose rise time is very much below the capability of your output tubes and transformer.

Manufacturers usually try to make up for lazy open-loop rise times by applying what they sometimes call an "optimum" amount of overall feedback, but in my opinion this remedy is worse than the disease it attempts to cure. Output tubes that mysteriously blow up due to 150 KHz oscillations into speaker loads are a fine example of what happens when you go for feedback to speed up uninspired amplifiers. I have had to fix quite a few so far in my shop.

Feedback can improve bandwidth but it does not guarantee dynamic stability when the amp has inadequate slew rate within the feedback loop. The problem is further aggravated when you consider that the slew rate of the stage can be considerably impaired if the load is suddenly changed. This is precisely what happens to many amplifiers of apparently good static performance cursed with driver stages that run out of steam when reproducing musical peaks.

I believe that underestimating the difficulty of driving the grid of a power tube is one of the main reasons why tube gear is famous for sounding "warm," "sweet," "mellow" and a bit "loose on the bass." Not the only reason, but a sadly overlooked one as far as I can see.

One can also consider the situation from the point of view of the output tubes. The two most common methods of biasing output tubes — cathode bias and fixed bias — are well known to readers of this magazine. Cathode bias looks simple and safe but this approach has serious drawbacks in push pull amps. The problems grow when the tubes are directly heated. In cathode bias schemes, the tube is left to itself to determine its idle operating point and in my experience a power tube is no good judge of its proper operating conditions. Even if separate resistors are provided for each push pull tube, you still have to provide a means for balancing the standing currents. Otherwise, no matter how carefully you match the tubes, you'll never get it right.

Of course, the optimal resistor value for a fresh tube won't be right as the tube ages and the standing current decreases. It is possible to implement a Williamson-style resistor array to make everything adjustable but this is not very suitable for directly heated tubes. Also, cathode bias exploits the useful life of the output tubes less efficiently. And then there's the problem of cathode bias caps. Electrolytics? No, cathode bias is not for me.

As if the above weren't enough, you must also bear in mind that a vast amount of power is wasted in cathode bias, especially when output tubes run at relatively high standing plate current or when high bias voltage is required. For example, if I cathode biased the Hidotrac, cathode resistor dissipation would be 2.7 W per tube (10.8 W total) thrown away heating the resistors — about 18% of the total plate input power! It is as if you attached an empty trailer to the back of your car with the only purpose of increasing the gas consumption by 18% for the same average speed. Not very sensible in my opinion.

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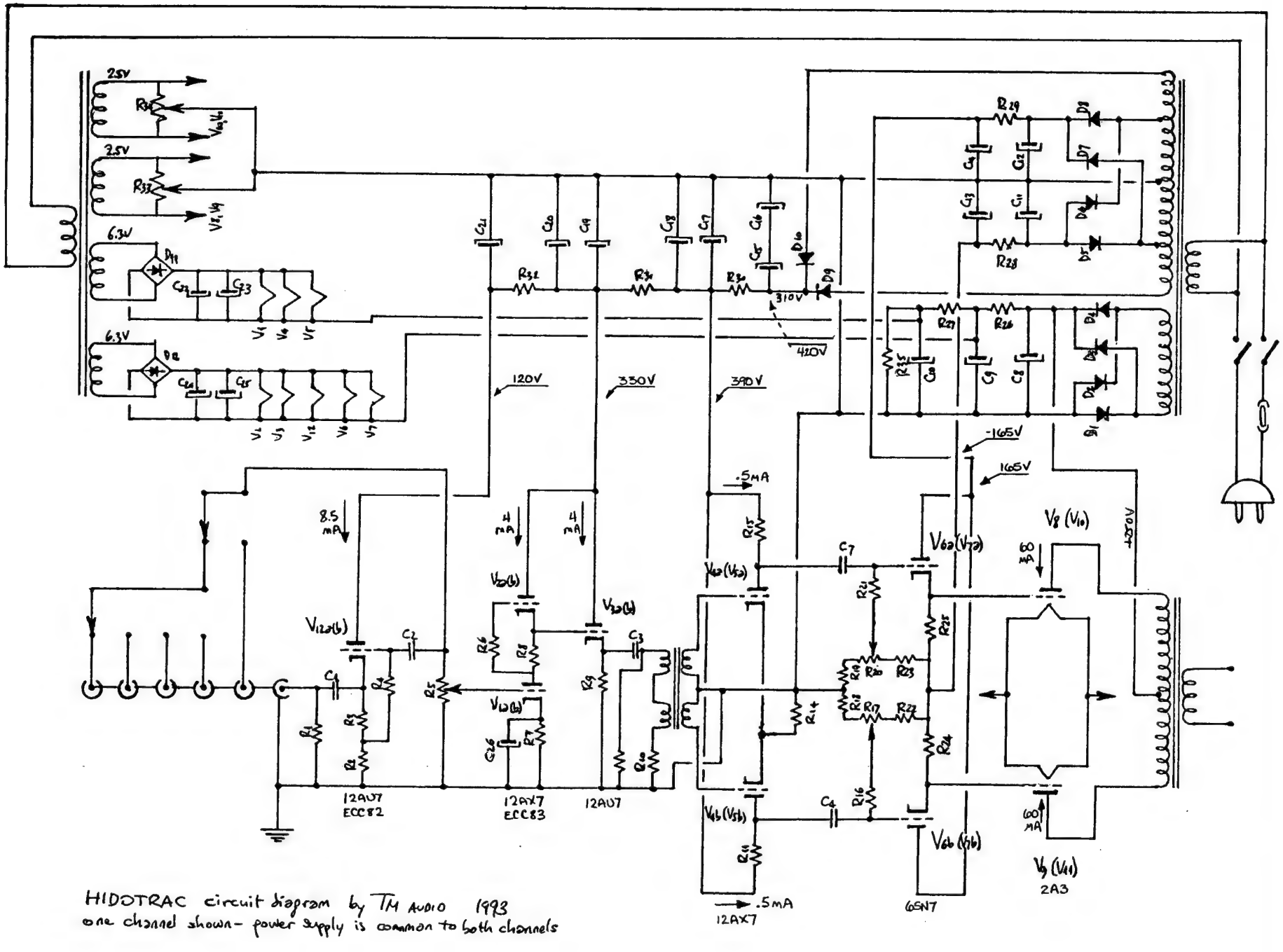
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HIDOTRAC circuit diagram by TM AUDIO 1993
one channel shown- power supply is common to both channels

PARTS LIST

R1, R4	1M
R2	2K2
R3	470R
R5	50K or 100K B taper pot
R6	0 to 470R
R7, R8	1K2
R9	15K/1W
R10	depends on xfmr; I used 1K8
R11, R15	120K
R14	470R (or use AC bal. pot)
R16, R21	470K
R17, R20	20K trimmer
R22, R23	100K 1/2W
R18, R19	39K
R24, R25	15K 2W
R26, R27	23k, 2W (2x 47k 1W parallel)
R28, R29	220 to 470R 5W
R30	680R 5W
R31	2K2 5W
R32	12K 5W
R33, R34	25 Ohm WW pot, 2W

C1	0.22uF 400V
C2	10nF 400V
C3	Solen 6.8uF 400V
C4, C7	0.22uF 400V
C5, C6	not used
C8	470uF 385V
C9	100uF 385V
C10	100uF 100V
C11-C14	470uF 200V
C15,C16	100uF 385V
C17-C20	220uF 400V
C21	100uF 385V
C22-C25	4700uF 25V
C26	220uF 16V Black Gate

D1-D4	BY225
D5-D10	1N4007
D11, D12	400V 8A

V1, V2	12AX7 or any high mu triode
V3	12AU7
V4	12AX7
V5	12AX7
V6, V7	6SN7
V8-V11	2A3
V12	12AU7

The author can provide the interstage transformers specified in this article for $64 /pr. + $10 Airmail post. Contact:

Diego Nardi
Via Volterra 12
20146 Milano M1
Italy

Fixed bias, obtained from a small power supply, makes it easy to set the standing current and requires no strange components from cathode to ground (except maybe a small resistor). However, the way bias supplies are usually made is far from satisfactory. Forget the old story that "bias supplies will never have to provide any considerable current". This is strikingly untrue! —especially as the amp is driven toward clipping. If you feed a grid from a poor power supply, as manufacturers of fixed bias amps nearly always do, you get poor control of the output tubes' "zero" point under dynamic conditions. Added to the fact that most amps have their output stage driven by a plate loaded driver stage or phase inverter which has limited authority to force the grids to obey its orders, there are obvious reasons why such gear sounds muffled and dynamically asleep.

But if you decide to make a more serious bias supply, you might as well use it to do something more interesting. So I said to myself: "Why not make a Class A, all-triode, no-feedback amp with a driver stage capable of gripping the output stage all the way to DC?" The way to do this is to use what our ancestors used to drive their AB2 units — a nice tough directly-coupled cathode follower pair hanging on to dual dedicated power supply rails. This does three things at one time that no other method can achieve:

1 — It biases the output tubes by means of adjustable voltage dividers that feed the grids of the *drivers*, which will never draw any appreciable grid current, unlike the outputs. This makes for very stable bias long term.

2 — It drives the output tubes with very low distortion and keeps them under strict control regardless of signal amplitude, even well into overload.

3 — Thanks to its low output impedance (around 200 ohms in my unit), the slew rate performance of this driver is not impaired by the input capacitance of the output tubes.

The drivers in this amp are 6SN7s with about 8 mA through each section. The 2A3s (Chinese) are run quite normally: plate voltage is 250 V when the standing current is set to 60 mA per tube. The plate-to-plate load is 3200 ohms with an 8 ohm load. OT ratio is 20:1 full primary to full secondary. Under these conditions, a pair of 2A3s is expected to put out approx. 8 W, then more or less gracefully slide into clipping. But here comes the surprise: while the THD at 7.5 W out @ 1KHz is still below 3% with a good spectrum (2nd at -34.5 dB, 3rd at -32.5 dB, 4th at -50, 5th at -49, and the rest below -60) this amp has the steam to go much further and only gives up at around 14 W. THD at 14 W is around 7% but the third harmonic is only 6 dB higher than the second. Not bad for a push pull being driven really hard into grid current, especially when you consider that all harmonics higher than the 5th are *still* below -60dB!

This class of operation might well be called "Class A2" or "Turbo Class A" or something like that. It yields a power output similar to that gained from Class AB1, but it offers true Class A linearity up to more than half-power. In addition, you have all of the advantages of the particular driver structure used, as described above.

The other lab performances are all satisfactory. I already mentioned power bandwidth. Slew rate is 3 V/uS. This amp can stand virtually any abuse without instability — including shorting the output at full power, then suddenly opening it.

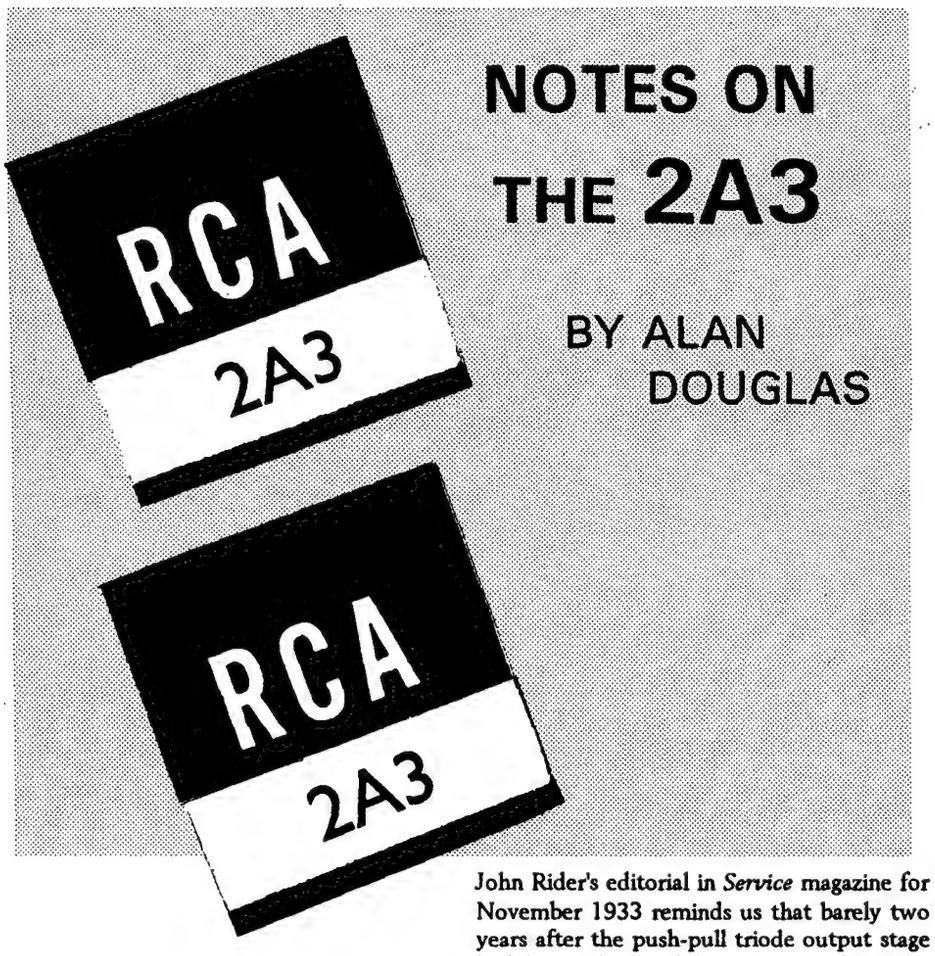
Some of you might fear that the life of output tubes will be shortened by this kind of operation, but I have seen no evidence of this so far. The unit has been working nearly 2000 hours, often switched off and on two or three times a day, and the original 2A3s are as new. I periodically check the idle current but, since I set it after an initial 100 hour run-in, I've never had to correct it.

The sound of this amplifier is interesting in that it is completely different from what is normally expected. It is anything but slow and soft, having a tough and live feel which is unmatched by any pentode/beam tetrode amp I have tried so far. The performance approaches excellent and very expensive single ended units like the Audio Note *Neiro Silver* I recently had at home for some time.

The Hidotrac turned in surprising results driving current-eating 84 dB speakers that have caused serious headaches for big solid state amplifiers! In my opinion, this amplifier can be confidently recommended as a full range amplifier driving reasonably efficient speakers — say 90dB or better.

NOTES ON THE 2A3

BY ALAN DOUGLAS



"Well, 45s are back again: or are they? It is indeed interesting to note that several of the recently announced radio receivers employ type 45 tubes in the output stage. Perhaps we are in for a 'back to the 45' movement.

Those men who have sworn by the old 45s will have a chance to crow. And you can't blame them much. The output with 45s is good, assuming that what precedes the output stage provides good quality. The power output is likewise sufficient for the ordinary home.

Quite a few of the receivers which used the tubes produced subsequent to the 45s are classed as having too much power, and are said to suffer slightly with respect to quality when the volume is reduced.

Will it last? Let's hope so."

John F. Rider, 1933

John Rider's editorial in *Service* magazine for November 1933 reminds us that barely two years after the push-pull triode output stage had been obsoleted by the pentode or by class B, many listeners wanted it back. Even though very few radio stations transmitted anything like high-fidelity at the time, the difference was quite audible. There was a story making the rounds of the 1931 Chicago IRE convention after the 47 pentode was introduced — though it was admitted to be exaggerated — that an engineer looked closely at a 47 and exclaimed, "Absolutely wonderful! Here we have 30% distortion in a bottle." Class B audio, the fad of the 1932 model year, was so bad that it was banished and never returned.

Economics had something to do with class B's demise also. Because of the current variations in a class B stage, a well-regulated supply that was decoupled from the remaining radio tubes was essential. Mercury-vapor rectifiers, prone to generating RF hash, were needed to lower the power supply impedance. Sometimes there were two rectifiers, sometimes two entirely separate power transformers!

If the old 45 was slightly underpowered for the job, then a new triode was evidently needed. The antiquated 50 consumed too much heater power and needed a high voltage supply beyond the ratings of the available electrolytic capacitors or practical rectifiers. If the 45 could run on 250 volts, why couldn't a tube of twice its output?

The problem was the cathode size required to handle the current demands of a low-voltage tube. RCA solved it by using 20 heater wires in series-parallel and wide flat plates. The 2A3 was introduced in the first week of February 1933, along with a companion 5Z3 rectifier.

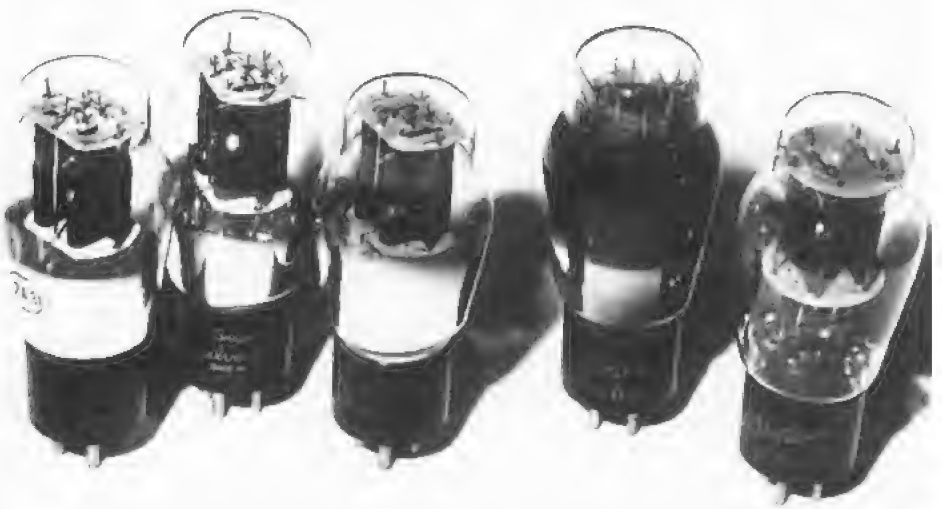
The curious fact is that although RCA intended its new tube for radio receiver use (high fidelity radios were then in the laboratory stage, according to the editor of *Electronics*), virtually no one ever used the 2A3: Scott used it in his Allwave 15, McMurdo Silver in his Masterpiece II, and that was about it. The 42 pentode (sometimes triode connected), proved to be an acceptable compromise, even to hi-fi fanatical Philco. Zenith regressed to using six 45s in push-pull parallel. On the average, a 2A3 cost three times as much as a 45 during the 1930s.

The 2A3 found its following in commercial sound, which may have been RCA's intention all along since RCA Photophone was in head to head competition with Western Electric's ERPI for theater installations. There was also an overseas market: witness the Brimar (UK) and Fivre (Italy) 2A3s that were identical to the first RCA model. Brimar, an acronym for BRItish Made American Range, is known to have imported US-made tubes for distribution and Fivre may have done the same.

Several US independents also made 2A3s starting in 1933, Sylvania and Ken-Rad to name two. Raytheon went them one better by making its own 2A3H with three parallel elements and cathode sleeves over the heaters. Raytheon's special sales feature was "four-pillar" construction, somewhat more rigid than the standard method, but unnecessary after the introduction of dome top bulbs in 1932. This feature made it impossible to swap tubes with other manufacturers, a normal industry practice; the Hytron pictured was actually made by RCA, as were the postwar Sylvania and Raytheon examples, while a single production line made the National Union, Silvertone, and Sylvania tubes shown.



RCA tubes from March 1934, August 1935, and ca. mid-1936. Raytheon 2A3H 1934-36. Base stampings have been whitened with chalk for visibility.



National Union, Silvertone, and Sylvania — Probably all NU 1950s, wartime Ken-Rad and 1950's GE. GE bought Ken-Rad in 1946.

In September 1935, Sylvania announced the 6A3, designed for the Philco 680X high fidelity radio. Electrically this was a 2A3 with a 6 Volt heater, but mechanically it was two triodes in parallel — considerably easier to build than RCA's original design. The independents soon began building 2A3s this way, as did RCA itself by May 1937 if not earlier. Other than a possible variation in hum balancing, there is of course no difference in performance for the two types. The trendy buzzword "monoplate" aside, this first version has *two* grids and *two* plates, and a heater facing in *two* directions. If the structures are not perfectly centered, these two directions will not have the same characteristics. Furthermore, the electric fields are *far* from uniform at the edges of the structure, and the effective grid bias varies with position along the heater and varies at a 60 Hz rate too! The electrons don't care: the total characteristic is the sum of all the electron currents, and the hum can generally be averaged out. Any variations in sound between tubes are likely due to differences in plate resistance interacting with varying speaker impedance over the audio range. One can build excellent amplifiers without invoking supernatural powers or magical mumbo-jumbo.

2A3

2A3
POWER TRIODE

GENERAL DATA

Electrical:

Filament, Coated:		
Voltage	2.5	ac or dc volts
Current	2.5	amp
Direct Interelectrode Capacitances (Approx.):*		
Grid to Plate	16.5	μμf
Grid to Cathode	7.5	μμf
Plate to Cathode	5.5	μμf

* With no external shield.

Mechanical:

Mounting Position	Any
Maximum Overall Length	5-3/8"
Maximum Seated Length	4-3/4"
Maximum Diameter	2-1/16"
Bulb	ST-16
Base	Medium-Shell Small 4-Pin
Basing Designation for BOTTOM VIEW	4D

Pin 1 – Filament
Pin 2 – Plate
Pin 3 – Grid
Pin 4 – Filament



AMPLIFIER – Class A_1

Maximum Ratings, *Design-Center Values*:		
PLATE VOLTAGE	300 max.	volts
PLATE DISSIPATION	15 max.	watts
Typical Operation and Characteristics:		
Plate Voltage	250	volts
Grid Voltage# ▲	-45	volts
Amplification Factor	4.2	
Plate Resistance	800	ohms
Transconductance	5250	μmhos
Plate Current	60	ma.
Load Resistance	2500	ohms
Second Harmonic Distortion	5	%
Power Output	3.5	watts
Maximum Circuit Values:□		
Grid-Circuit Resistance	fixed bias 0.05 max.	megohm
	cathode bias 0.5 max.	megohm

#, ▲, □: See next page.
→ indicates a change.

2A3

2A3
POWER TRIODE

PUSH-PULL AMPLIFIER – Class AB_1

Maximum Ratings, *Design-Center Values*:		
PLATE VOLTAGE	300 max.	volts
PLATE DISSIPATION	15 max.	watts

Typical Operation:
Values are for 2 tubes

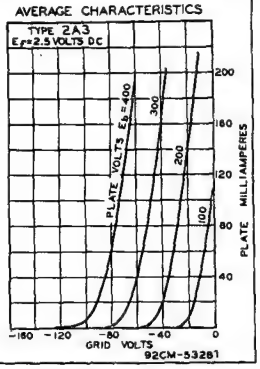
	Fixed Bias	Cathode Bias	
Plate Voltage	300	300 ◇	volts
Grid Voltage#	-62	–	volts
Cathode-Bias Resistor	–	780	ohms
→ Peak AF Grid-to-Grid Voltage	124	156	volts
Zero-Signal Plate Current	80	80	ma.
→ Max.-Signal Plate Current	147	100	ma.
Effective Load Resistance (plate to plate)	3000	5000	ohms
Total Harmonic Distortion	2.5	5.0	%
Power Output	15	10	watts

Maximum Circuit Values:□

Grid-Circuit Resistance	fixed bias 0.05 max.	megohm
	cathode bias 0.5 max.	megohm

Grid voltage referred to mid-point of ac-operated filament.
* When a single 2A3 is operated cathode-biased, the cathode-biasing resistor value should be 750 ohms.
□ The type of coupling used should not introduce too much resistance in the grid circuit. Transformer or impedance-coupling devices are recommended.
◇ For zero-signal conditions.

AVERAGE CHARACTERISTICS



→ Indicates a change. 92CM-53281

SOUND

Design of Audio System Employing 2A3 Tubes

Copyright, 1933 by
RCA Radiotron Co., Inc.

THE introduction of the 2A3 made possible the design of audio-frequency output systems of unusual power-handling ability and exceptional tone quality. The unique design features incorporated in the 2A3 make possible very high power output at relatively low plate voltages. Used in a suitable audio-frequency power amplifier, two 2A3's in Class A push-pull are capable of delivering 15 watts of audio power to the output transformer with a total harmonic distortion of less than 2.5 per cent.

Two of the more important design features of the 2A3 are its multifilamentary cathode and its extremely high mutual conductance. The multifilamentary cathode consists of a large number of coated filaments arranged in series-parallel combination to provide a very large effective cathode area.

Graphical Solution for the Selection of 2A3 Operating Conditions

In determining the performance obtainable from two 2A3's in Class A push-pull and in selecting output transformer constants, a graphical method of solution can be used. For a general consideration of the method for determining the performance of push-pull audio amplifiers by graphical means, see the paper entitled "Graphical Determination of Performance of Push-Pull Audio Amplifiers" by B. J. Thompson of our Research and Development Laboratory. This paper appeared in Proceedings of the Institute of Radio Engineers for April, 1933.

CLASS A OPERATING CONSIDERATIONS FOR THE 2A3

Class A General Operation

THE usual operating point of grid-bias voltage for a Class A amplifier lies approximately midway between zero bias and a bias sufficient to cause plate-current cut-off. If a single tube is used in Class A operation, the operating bias voltage must be such that the DC plate current does not change appreciably when full signal voltages are applied to the grid. Only under such conditions can an output having low distortion be obtained.

Strictly speaking, no type of output tube has absolutely linear characteristics. Consequently, a small amount of rectification of the signal voltage usually occurs. The non-linearity of characteristics is therefore responsible for the distortion produced by the tube.

When two tubes are operated in a Class A push-pull circuit, the non-linear sections of their characteristics are made to complement each other to give a substantially linear overall characteristic. This method produces an output free from second harmonic distortion. For this reason, it is possible to use a higher bias voltage for push-pull operation than is usually employed for single-tube operation. An increased bias voltage lowers the internal dissipation of the tube and permits the use of higher plate voltages. Higher plate voltages, in turn, make possible higher power output.

In order to obtain the higher power output of which the 2A3 is capable, two of these tubes are operated in push-pull under bias-voltage conditions which cause considerable rectification in each tube. Additional plate current, then, is drawn because of rectification, but this increased plate current is useful in securing higher power outputs. Under normal recommended operating conditions in a push-pull amplifier, where a plate-supply voltage of very good regulation and a fixed-bias supply voltage are used, the plate current is not cut off during any fraction of the cycle. Consequently, even though the recommended operating conditions specify over-bias grid voltage, this system may be operated as a strictly Class A amplifier.

2A3's should not be operated with more than 300 volts on the plate. The grid-bias voltage should be —62 volts when operated from an AC filament supply and —60 volts when operated from a DC supply. The corresponding static plate current for an average 2A3 is 40 milliamperes. This voltage and current rating for no signal input should not be exceeded for best results.

Fixed-Bias Operation of the 2A3 With Over-Bias Voltage

FIG. 2 shows a circuit arrangement for the 2A3 in which the bias voltage is obtained from a small triode used as a rectifier. This triode must be a type whose cathode comes to an operating temperature quickly in order that bias will be available to prevent abnormal plate current in the 2A3's. Either a type 26 or 01-A is suitable for use as the bias rectifier.

With the circuit of Fig. 1, changes in the DC plate current of the 2A3 produce some change in bias. With the circuit of Fig. 2, the bias voltage is substantially independent of the plate current of the 2A3's.

The ideal case of fixed-bias operation with a fixed plate-voltage supply gives results as shown by the curves marked (I) in Fig. 3. The curves (II) show the performance with fixed bias but with a plate-supply source having an equivalent internal resistance of 562 ohms. This represents the condition for the circuit of Fig. 2 when a 5Z3 with suitable transformer is used. The performance with an 83 type is intermediate between the values of curves I and II of Fig. 3.

The plate circuits of the 2A3's should be fused in the center-tap lead of the output transformer. This is especially important when fixed bias is used. Should the bias-voltage rectifier tube be removed or damaged, the bias on the 2A3's becomes zero. In that event, unless a fuse is provided for protection, excessive plate current can flow and damage the receiver. A suitable fuse is one similar to the small glass-enclosed type often used to fuse the power-supply line in radio sets and rated at 150 milliamperes.

Self-Bias Operation of the 2A3 With Over-Bias Voltage

WHEN 2A3's are operated in a push-pull circuit and are self-biased, a rise in DC plate current with increasing signal voltages increases the voltage drop across the self-biasing resistor and raises the bias on the tubes. Thus, the operating point on the plate family of the characteristic curves is shifted downward. This shift tends to increase distortion and to lower the power output. Under these conditions, operation intermediate to Class A and Class B is usually obtained at full output since the plate current is cut off for an appreciable fraction of the operating cycle.

When self-biasing circuits are used for the 2A3, it is necessary, therefore, to employ a higher value of plate-load resistance than is used with a fixed or semi-fixed bias arrangement. The purpose of this high resistance is to lessen plate-current swings, limit distortion, and prevent plate-current cut-off at negative signal swings.

Performance of a 2A3 amplifier for self-bias operation (self-bias resistance of 780 ohms) and an assumed internal resistance of the plate-voltage supply of 562 ohms is shown as Curve IV in Fig. 3. A comparison with Curve I, which represents the ideal case of fixed supply voltages, shows the necessity of using a high plate load, as previously stated, in order to obtain high power output and low distortion. Increasing the internal resistance of the plate-voltage supply to the somewhat higher values often used commercially will not materially change results from the values of Curve IV.

The circuit diagram in Fig. 3 shows the equivalent voltage-supply circuit for the plate and grid-voltage supply. The plate and bias voltages on the power tube at zero-input signal are 300 and —60 volts, respectively. (For AC filament supply, grid-bias voltage is —62 volts).

Curves I to IV show the performance of the amplifier for four combinations of the internal resistance values of the plate-voltage and grid-voltage supply. The plate- and grid-supply voltages are adjusted to the values given above. These curves show that it is desirable to use a bias arrangement which will not give bias-voltage fluctuations when the DC plate current changes. Semi-fixed and fixed-bias arrangements allow higher power output levels to be maintained with a high degree of fidelity.

Semi-Fixed-Bias Operation of the 2A3 With Over-Bias Voltage

FIG. 1 shows a circuit arrangement employing semi-fixed bias for the 2A3. The bias voltage is obtained across the speaker-field resistance. Since the plate current for all of the tubes in the set flows through this resistance, the bias voltage is less affected by the DC plate-current changes in the 2A3's than it is in a self-biasing circuit.

TYPICAL POWER-AMPLIFIER CIRCUITS WITH SEMI-FIXED AND FIXED BIAS

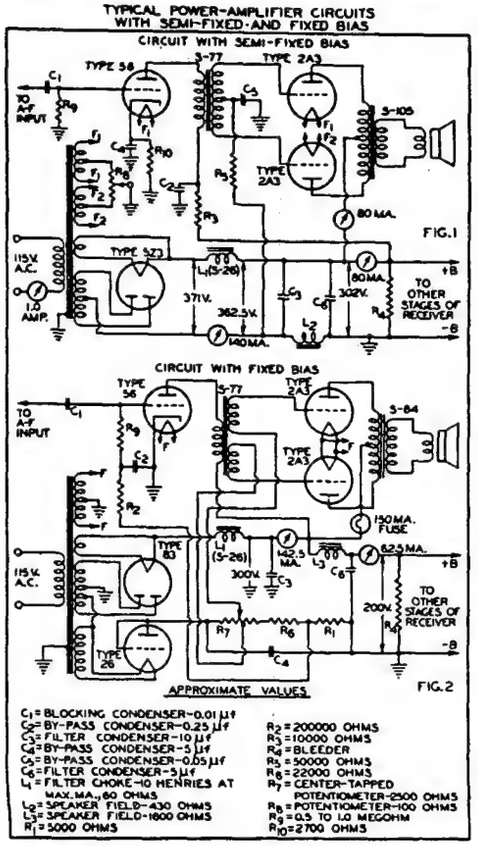
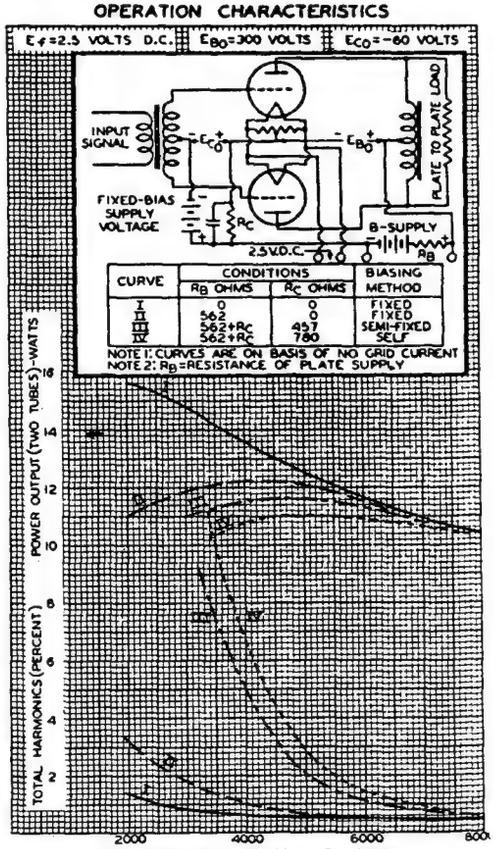


FIG. 1 FIG. 2

C_1 = BLOCKING CONDENSER-0.01 μf
C_2 = BY-PASS CONDENSER-0.25 μf
C_3 = FILTER CONDENSER-10 μf
C_4 = BY-PASS CONDENSER-5 μf
C_5 = BY-PASS CONDENSER-0.05 μf
C_6 = FILTER CONDENSER-5 μf
L_1 = FILTER CHOKE-10 HENRIES AT MAX. MA., 60 OHMS
L_2 = SPEAKER FIELD-430 OHMS
L_3 = SPEAKER FIELD-1600 OHMS
R_1 = 5000 OHMS
R_2 = 200000 OHMS
R_3 = 10000 OHMS
R_4 = BLEEDER
R_5 = 50000 OHMS
R_6 = 22000 OHMS
R_7 = CENTER-TAPPED POTENTIOMETER-2500 OHMS
R_8 = POTENTIOMETER-100 OHMS
R_9 = 0.5 TO 1.0 MEGOHM
R_{10} = 2700 OHMS

OPERATION CHARACTERISTICS



DEC. 19, 1933 FIG. 3 925-5430

The circuit constants shown in Fig. 1 are those for a typical receiver. Since the speaker-field resistance determines the 2A3 bias, it follows that the choice of resistance depends on the total plate-current drain of all the tubes in the set. The performance with this circuit is represented by Curve III.

Balancing of 2A3 Circuits

IT MAY be advisable to provide some means for balancing the plate currents of the 2A3 tubes, as this has the effect of balancing out hum voltages present in the plate-supply voltage.

Two methods of accomplishing this are shown in the circuit diagrams. In Fig. 1, a small potentiometer (R_8) is connected between the center taps of the filament windings to permit an adjustment of bias voltage. In Fig. 2, the secondary of the input transformer consists of two separate windings. One lead is attached to the center of the potentiometer (R_7) and the other to the slider or arm of the same potentiometer. Adjustment of the potentiometer varies the bias slightly on one of the 2A3's.

Small amounts of hum due to various causes can often be eliminated by adjustment of the potentiometer. Adjustment of the potentiometer for minimum hum usually gives equal plate currents. The potentiometer is adjusted by listening for minimum hum upon installation of the 2A3's in the set. It should not require readjustment until one of the 2A3's is changed.

Power Transformer

BOTH the circuits of Fig. 1 and Fig. 2 are designed for use with typical commercial power transformers. There are no special features involved in the design of the power transformer. Any make of transformer having the appropriate voltage windings, correct rating, and good regulation may be used.

Pre-Amplifier Stage

A TYPE 56 tube is used in the pre-amplifier stage, since this tube gives excellent power sensitivity. The 56 also is an economical type.

A plate-supply voltage of 200 volts for the 56 is adequate to give the output signal required to swing the 2A3's. This is the voltage available for plate supply to the other tubes in the set under conditions given in Figs. 1 and 2. The 56, with 200-volt plate supply, is operated with a bias of —11 volts. The plate current is 3.6 milliamperes.

Input Transformer

THE same input transformer, specifications for which are shown here, is used for both the semi-fixed and fixed-bias arrangements. Commercial-size audio-transformer laminations are used.

The ratio of the input transformer is 1.4 to 1 from the full primary winding to one-half of the secondary winding. The peak voltage which will be induced in the secondary winding is 2 x 90 or 180 volts at the point at which the 56 begins to draw grid current.

In determining the constants for the input transformer, cost, size, response characteristics, and signal requirements must be considered. In order to obtain a low-cost small-size transformer with primary inductance high enough to give good frequency characteristics, a step-down ratio is used. A step-up ratio would require a larger transformer design in order to provide space for the additional secondary turns. However, under the circuit conditions shown, the step-down ratio can give a signal input to the 2A3's sufficiently large to obtain their full output.

Transformer Specifications

Power Transformer S-79A*

CORE:
Material—Transformer Steel
Allegheny Steel Co. or equivalent
Punching—EI-13A
Stack—1¾-in.
Weight—4.9 lbs.

PRIMARY:
Resistance—2.4 ohms

SECONDARY:
Resistance at 25°C—2 x 106 ohms
Induced voltage—2 x 375 volts RMS
Induced voltage from center-tap to tap for bias rectifier—approx. 57 v RMS
Total weights of copper—1.0 lb.

Input Transformer S-77 *

CORE:
Material—Audio B
Allegheny Steel Co. or equivalent
Punching—EI-75
Stack—¾-in.
Joint—Butt
Weight—0.6 lb.

PRIMARY:
Turns—5000
Location—Between two halves of secondary winding
Turns per layer—240
Layers—21
Insulation between layers—0.001-in. paper
Wire—No. 40 enamelled
Resistance at 25°C—2000 ohms

SECONDARY:
Turns—Two windings of 3600 turns each
Location—One-half over, one-half under primary
Turns per layer—240
Layers—2 x 15
Insulation between layers—0.001-in. paper
Wire—No. 40 enamelled
Total weights of copper—0.14 lb.

Output Transformer S-84 *

CORE:
Material—Audio C
Allegheny Steel Co. or equivalent
Punching—EI-11
Stack—⅞-in.
Joint—Lap
Weight—1.0 lb.

PRIMARY:
Wire—No. 32 enamelled
Turns—1400 tapped at 700
Location—Next to core
Turns per layer—105
Layers—14
Insulation between layers—0.0015-in. paper
Resistance at 250°C—98 ohms

SECONDARY:
Turns—32
Location—Wound over insulated primary
Wire—No. 15 enamelled
Turns per layer—16
Layers—2
Insulation between layers—0.005-in. paper
Secondary load—Voice coil of electro-dynamic speaker having an impedance at 60 cycles of 1.06 ohms.
Resistance at 25°C—0.053 ohms
Output—13.3 watts into a 1.06-ohm load at 60 cycles
Total weight of copper—0.24 lb.

Choke S-26 *

CORE:
Material—Dynamo Steel
Allegheny Steel Co. or equivalent
Punchings—EI-12
Stack—1¼-in.
Air gap—0.004-in. x 2
Weight—1.88 lbs.

WINDING:
Turns—1780
Turns per layer—81
Layers—22
Insulation between layers—0.003-in. paper
Resistance at 25°C—approx. 60 ohms
Weight of copper—0.47 lb.
Inductance—approx. 10 henries (conditions as in Fig. 2)

Output Transformer S-105 *

CORE:
Material—Audio C
Allegheny Steel Co. or equivalent
Stack—0.875-in.
Joint—Lap
Weight—1.0 lb.

PRIMARY:
Turns—2000 tapped at 1000
Location—Next to core
Wire—No. 33 enamelled
Turns per layer—118
Layers—17
Insulation between layers—0.0015-in. paper
Resistance at 25°C—172 ohms total
Inductance—19.5 henries (at full signal)

SECONDARY:
Location—Wound over primary
Turns—2000 divided by the square root of $[5400/(R_L+r_2)]$ where,
R_L=external load resistance on secondary terminals
r_2=resistance of secondary winding or approximately 6% of R_L.

* Our design identification number.



RCA 2A3 tubes in chronological order:
Red-label from May-June 1937, followed (left to right) by wartime, late 1940s, and 1950s production.



photo:Victoria Clay

. . . the story they said would never make it to the screen!!!

SEE Future Boy go digital!

HEAR the real story behind the cheap, skipping portable CD players!

FEEL the cruel torture of the ripoff master technicians wringing the last drop of our famous hero's blood!

Only in the genius autobiographical shocker . . .

THE RETURN OF FUTURE BOY
BY
VINNY "21ST CENTURY" GALLO
(OF VINNY GALLO'S "MONO MIA" FAME)

R

BARGAIN MATINEES EVERY DAY
ALL SHOWS STARTING BEFORE 6PM

WIDE RANGE
Western Electric SOUND SYSTEM

Sound Practices gets 8000 fan letters a day praising my famous articles, 10,000 fanatic fan faxes addressed to me, and the office gets swamped with hundreds of phone calls from thrilled Gallo fans from around the world. And one time, one lousy time, the Gallo receives negative criticism, and boom! there it is in print: Volume 2 #1 page 44, that's right! center page. Joe Roberts, you sneaky rat bastard. How could you do it to me, Joe, you half a man, you Judas? How could you print that piece of crap letter, you ungrateful spineless worm? And as far as being able to afford the damn Ongaku, don't make me laugh. I'm rich, you fool.

Besides, the fans want the Gallo, the real thing, the one and only — ME. That's right, ME! Not all those pale imitations of me. They want Vinny G, Doctor Brown, Grandmaster Vincenzo, Kid Hi-Fi. Me, that's right, *me*. The Gallo.

So Ladies and Gentlemen, my faxing fans, my praising pen pals and all my loving callers, the Gallo is back. I'd like to first thank you for taking time out from one of those ridiculous waste of time amp columns to read my latest hi-fi poem. It's about the life, death, and resurrection of Vinny 21st Century, Future Boy.

Born Vincent Gallo in Buffalo, N.Y. in 1961. Grew up there poor with his mom and pops (immigrants from Sicily) during the 60s and 70s. His pops was very proud. His whole family lived on plain boiled macaroni but he insisted on driving a brand new Cadillac every year. He had to have it, always black with that white interior.

Every time Future Boy sat in it, he got a beating for dirtying the seats and carpeting. Pops, even though he's got three little kids, he's still gotta have a white interior. Future Boy loved going with his pops to the dealership to pick up the new car. In the 60s it felt like each year the new things got better and better, it was so exciting. Future Boy thought by the time he was 21 all disease would be curable, cars would fly and run on water and people would live forever and stay young looking. He'd fly the first spaceship to Pluto. He loved all the new modern things. He was a techno-loving guinny, Vinny 21st century, Dr. New. His friends called him FUTURE BOY.

And that was me, I was future boy. But one dark day my daddy picked up his new Caddy and started complaining about it, things like "Ah I shoulda kept the old one, Goddamit! Look at this cheap thing." Then one week later he traded it back in for a new version of the last year's model. It was the last one on the lot and he had to take a gold with a black interior. He kept that car 10 years, 'till my half deaf, half blind grandpa drove it over my uncle Angelo's favorite lawn statue of St. Anthony of Padua, through his tomato plants and into the side of the Bunza's house next door. No one was hurt, but my pops' last great Caddy was gone. Forget the tomato plants and that beautiful statue. Pops' Caddy was killed and he would never love another one. He drove them, yes, but he never loved them. It feels horrible to be disenchanted with new things and the future. It's the tragedy of the 20th century.

By the age of 18, "Future Boy" was dead. After that I started running around pumping old folks with the "what was it like back then" question. I've spent most of my adult life wishing, wishing it was still like that, wishing they still made those, wishing it was still there, wishing people still did that, wishing you could still buy them. Wondering why they stopped making them, wondering why they had to change. And it wasn't even a nostalgia trip, after all I hated Elvis and that whole 50's thing. But it just felt like all the great things had already happened. I became stuck, locked into an image of the past and cynical about the future.

I began romanticizing things that were just normal for the people who experienced them. For instance, I love my 1951 blond D'Angelico New Yorker cutaway guitar, sounds great, it's incredible. It's super cool but a lot of tired businessmen now want it so they can pretend that they are a jazz legend. This guitar is now worth 75,000 dollars. Great jazz players can sound good on any guitar. They bought D'Angelicos in the 50's because at $300 it was a fine hand made working guitar they could use to make $75 a week playing in a band 7 nights.

I would buy some old guy's old car and spend months and tons of money and aggravation trying to make it original, like new. I'd look up from under my car, grease on my face, the old bastard who sold it to me would be driving by in his brand new car, steering with a pair of clean hands. And laughing. And me thinking I was so smart and cool.

Like an asshole I spent $30,000 minting a 1967 Chevy II SS. The car is cool, no question. It's fast, good looking, but let's face it, it's just an old car. No air bag, no seatbelts, it's loud, bumpy, bad on gas. I think the people who I drive past enjoy it more than me. They get to go, "Wow, look at that neat ol' car," then go back to their happy lives, while I the asshole drive it back home to start fixing it again. I was insane to sink $30,000 into it. The car is an emotional burden. A few months ago I drove the $22,000 brand new 1994 Chevy Impala SS. It was cool, fast and good looking. And it was brand new. Nobody else's dirty fat ass rested on its brand new seats. I didn't have to leave it with the paint guy for 6 months, I didn't have to make 7000 phone calls tracking down rare original parts. It was right there man, brand new with a warranty. And I loved it and I want it, and as soon as I can find another loser like me who'll give me some cash for my '67 I'm gonna run and buy the '94.

I love new things again. And it feels great and I don't have to and haven't stopped loving great old classic products like my hi fi gear or my old D'Angelico or my great old stove. But the '67 Chevy, that's got to go. Old cars are like an old pair of underwear. They stink. Although I would travel long and far and pay top dollar for an old pair of dirty panties for my collection, I still prefer a brand new pair of cotton Jockey midways for wearing comfort.

Future boy is back and he's better than ever 'cause this time, not only do I have an interest in everything that's new and fresh, but have kept my interest, experience and knowledge about what came before so I can enjoy the whole picture, pick and choose. And then move forward. With excitement and hope.

This guy from the New York Times calls me today, Rene Chun, says "Hey Mr. Gallo, I heard you're an expert on vintage hi-fi. I'm writing an article for the Style section of the Times and wanted to ask you some questions." I say, "Sure, buddy." So he's pumping

. . .wow, vintage hi-fi in the Style section of the Times. . .

me about the Garrard 301 and I'm answering but I'm thinking, wow, vintage hi-fi in the Style section of the Times. . .

Garrard makes a turntable like the 301, produced first in 1953. It's well made, sounds great and looks great. Was one of the best in its day. However, they themselves change and alter the model and eventually replace it, meanwhile a bunch of other tables got offered and sold. Newer and newer stuff all the time. Some junk, some of it not so bad. Guys like me rediscover the original and buy them at junk sales for 5 bucks, set them up and love 'em. A bunch of people get hip and the piece becomes worth $600. Suddenly a used primitive worn-out table from 1953 becomes a $600 turntable and the feeling is that everything new is junk. Then the fashion boy journalist from the Times calls; next thing you know it's a prop in an MTV video. And starts selling like hotcakes for $2000 to fashion models. You can't give away vinyl anymore and boom, suddenly the Times is doing articles on stylish vinyl record players from the 50s.

Anyway, don't fool yourselves, vinyl won't make a comeback, it may be trendy but not for long. Love and keep your records. But new things are coming out and you might, if you let yourself, really love them. For example, I love my VCR and Laser Disc player. Of course it's thrilling to see an incredible film at the most beautiful old movie theater on a lovely summer night. But I've also heavily enjoyed staying at home during a blizzard and watching a great film on laser disc, eating Provolone cheese in bed with a fat hooker. I love them both. Besides, a great film at home on laser disc is more fun than seeing a shitty movie in a shitty theater. The thing is to allow yourself to enjoy them both for what they are.

I know a famous fashion photographer, he makes millions, says to me, "Hey Gallo, you like old things, I want to buy an old Mercedes from the sixties, I saw one I liked for $35,000, what do you think?" I'll tell you what I think. No, don't buy that piece of shit old car for $35,000. Stop trying to be cool, just get yourself a nice new car. And enjoy it. I think that it's great to be hip enough to appreciate old products, to be sensitive to their beauty and quality, but some old things are a pain in the ass and one shouldn't be a slave to them out of fashion or cool. Everything new is not junk and everything old is not great. For example, how would you like to do your laundry with a good looking, beautifully made old fashioned cool clothes washer? Try spending the day winding clothes through rollers 100 times to get them clean.

Why isn't it cool anymore to drive a new car? Or wear new clothes? When I was a kid, new clothes were very cool. What happened? And who thought of distressed leather or stonewashed jeans? Screw that. I want a brand new car. I've changed, I don't want every single thing I buy to have to be hard to find and difficult to use so I can feel special and cool. Man, I want to be open and interested in everything. I'm Vinny 21st century, that's right, Future Boy, Dr. New. But try touching my Western Electric gear and I'll kill ya!

I had my first real run-in with CD about 4 years ago; I'm in L.A., friend of mine there works in a record shop. Desperate he calls me up for cash (junkie). "No loans," I say, "but come over and I'll give you a twenty." A minute later he shows up, takes the $20 and offers me a pile of CDs for another $100. There's about 200 CDs. "I don't want 'em," I say. Tears fall, he begs. "Okay, okay, I'll take them." He takes the money and runs.

GREAT!!! There I was, Vinny Gallo, Mr. Western Electric, Mr. I'm-only-into-mono-tube-gear, Mr. I'll-never-own-a-CD-player-in-my-life, Mr. I-make-my-own-pizza-from-scratch and a junkie just sold me 200 CDs. What could I do? The guy was crying. A week later I'm talking to the King, no not Elvis, the Bender, Walt Bender. Bender's cool. However, I've never seen him actually play a record. He has very cool gear, yes, but he listens to it only with a Patsy Cline CD through a cheap portable CD player.

We're talking CD and he tells me about a guy named Scott Nixon who hand-builds a D/A processor in N.C. It's supposed to be good and it uses tubes. It must be OK if it has tubes, right? I call this cat up. He agrees to build me a tube unit and will model it after my WE 41 42 43 amp. Big thick black face plates, cool old meters, bakelite knobs, old style switches. Ya know. We discuss installing some WE input transformers and he agrees to build it mono (monomia!) Thanks, Scott, bye.

That's the last time we spoke. He's never returned one of my many calls since. I refused to give up on him for three years, partly 'cause I thought his was the only good one made and because his had tubes, and he shared his last name with my idol Richard.

Anyway, after no returned calls for three years I broke down. It was one night again in L.A. I was at this 24 hour electronic store, "The Good Guys". It's 2 a.m., I'm with a chick buying batteries for her massager, we walk past the portable CD display. There are 70 choices and you can A/B them through head phones. The Gallo's ears pick out a Magnavox Model AZ6827C. I actually buy it. My first CD player. Got a $200,000 collection of vintage hi-fi gear and I buy a $200 portable CD player. It's got an adapter to play through my car cassette deck. Five minutes later, me and the chick are driving around listening to a CD in my car while she's installing the batteries in her massager. I loved it. I was skipping and back spacing and skipping. I've always hated the fastforward and rewind on cassette. This was great. The next morning first thing, I'm at five different hi-fi shops looking at CD stuff, saw it all. That night I try Nixon again, leave a message, "Scott, hi, it's Gallo. Please, I'll take any unit you got ready, please, please call me." He never calls The Gallo back, the *minchia*.

So I call up my pal Mark Lyons. My pal who looks like a cop. Best guy I know. He's my favorite cop. Also has some great hi-fi gear — he's kinda the poor man's Vinny Gallo. Mark will spend on the right piece. He's got taste. And a good wife. So we're talking CD. He gives me his famous ten year old line, "I'm not spending money on an expensive CD player." I said, "Listen you cheap bastard, you listen to CDs all the time, get rid of that bullshit Sony player and come shopping with me." "No way," he says.

Anyway, he tells me that Joe Grado, Dick Sequerra, and some other guys have discovered a $150 CD player that blows them all away. Mike LaFevre told him about it. The Realistic Model 3400 portable. "A portable!" I say, "I already have a portable." "Mike La Fevre says this one is supposed to be awesome," he says.

And like a retard I rush to Radio Shack to buy it. Let me remind you that Joe, Dick and Mike (sorry Mike) are all cheap penny pinchers and I'm sure they never listened to a real D/A and transport in their lives. And the real Tricky Dick, Dick Sequerra probably saw an opportunity to sell people his over priced $500 power supply to fire up their crap machines. Thought batteries worked best but they get eaten fast so with mine I made up a power supply using a motorcycle battery and a cheap charger.

Within a week though, both my and Mark Lyons' machines were skipping. I shoulda known. It's built like a real piece of shit but the killer punch was when Lyons and I compared the cheap, skipping Realistic to the cheap, skipping Magnavox and the cheap, skipping Magnavox blew it away. So if you want to own a smelly cheap ugly piece of shit CD player that lasts about a week, definitely get the Magnavox.

. . . I compared the cheap, skipping Realistic to the cheap, skipping Magnavox and the cheap, skipping Magnavox blew it away. . .

The horror of this part of the century is that people are so willing to buy the cheapest and poorest engineered and manufactured products, therefore all the new technologies never really seem exciting. And people confuse themselves by romanticizing old products that were made well without recognizing the glory and possibilities of the new technology around them. It's really not that things are not more evolved or can't be made as well, there are just fewer people who put value on these kinds of products.

For example, push button phones blow away the old rotary type, yet when rotary types were made they were made to last by the phone company and they were expensive. But there are millions of the shittiest push button type built now. They break like crazy, so in our delusion we begin to romanticize the rotaries, while purchasing the cheapest push buttons we find on sale. Well, if we were all willing to pay for the highest quality push button type and that was all that was around, only a big asshole could possibly romanticize the rotary type.

So why do guys who are so willing to spend tons on vintage hi-fi— say $500 for a Western Electric 300 B tube, HA HA HA! or $10,000 for a pair of shitty sounding Marantz model 9s, or $3500 for the winner of the overrated amp of the century award, the Mac 275 or the Marantz 7C for $2000, man that pre-amp is so dry it's like a pair of dead chapped lips. (. . . and don't tell me about your "modified" 7C or I'll fart) —why are *they* the guys who own the cheapest shit CD players? Don't they know the way those beautiful collectibles held their value was because originally they were designed, engineered, and built on the highest level and of course they were expensive? Dick Sequerra's FM tuner was incredible and shockingly expensive, a real classic, yet we should buy a $150 CD so he could sell us the $500 power supply? The 3400 and the $500 Tricky Dick power supply together will be worth a nickel by Christmas.

Once I got the cheap portable shtick out of my system, I pulled out ten copies of 'Stereo Sound', a Japanese magazine I pay $40 each for, to get maybe 2 pages of Western Electric gear photos to squirt on. Suddenly, I'm on the floor groping, looking at all the photos of CD gear. I'm obsessed, excited and loving the future. There's pictures of all the players, converters and transports. I start talking CD to everyone, to hi end guys, tube nuts, technos, Romantics — anyone who will talk CD. I beg to borrow everything and listen to it through my Western Electric 300 B amps and several different WE horn systems. I spend six months researching. I ship things from France. I drive all the way to Chicago. I went crazy, bought, sold, bought, sold. I forced myself through piles of *Absolute Sound* and *Stereophile* reviews. I did it all. And it was tons of fun.

The whole time I would compare CDs and records either against my EMT 927 turntable arm and cartridge or a Garrard 301 with Ortofon arm and cartridge. By the way, the EMT 927 is awesome. So the CD setups had to battle against the best. The very best. I listened through push pull triodes, (Western Electric 86s), then single endeds (Western Electric 91s), then pentodes (Western Electric 124s), through Marantz 1s and direct into the amps. I even set up stereo using Western Electric 757s. Then a

pair of Western Electric 755s, then back in mono with one 757. Then my dream system, a single Western Electric 4171 bass, Western Electric 26A horn, Western Electric 594 driver and Western Electric 597 tweeter, Western Electric TA7331 baffle, a Western Electric 26A horn biamped with a Western Electric 86C, Western Electric 91A and Marantz 3 crossover.

I had my gear all wired up with the fantastic incredible sounding Kimber KCAG interconnect wire and Kimber 4AG speaker wire which blow away any other wires I've ever heard in my life. And I've heard them all. The Kimber stuff is perfect for all you triode tube freaks, incredibly smooth and detailed. That cool cat Jack King and the boys of Kimber know all about triode tubes and horns. Imagine a hi-end wire company with guys hip to tube gear. Wow! Jack King and Kimber, we love ya.

While living with CD plugged into my best system alongside the turntable of all turntables, the EMT 927, I noticed that I loved the ceremony of records, the smell, touch and beauty of them. You drop the arm down, go sit, ears cocked and listen, really listen. Oh boy do I listen, but most often to the same few records. The ones that make the system sound best. With CDs I'm a bit more liberated. I listen to music I want to hear, not just what made my system sound best. I did other things while listening, like clean the house, chat with friends. I would never chat over a record. I love the ease of skipping songs or repeating them with the remote, I can move around. I can even fall asleep with the hi-fi on. I found I was using my hi-fi much more. I could also use the CD to learn songs on guitar, it's so easy to return to a spot in a song. What kind of jerks would totally refuse owning a CD player? And isn't that like saying that you have absolutely no interest in new music? I want to be interested in new music and I don't have to throw away my old records. I can have it all. You know, my girlfriend Victoria has been banned from my system since the day she trashed the stylus off my EMT TMD 25 cartridge. But with a CD deck in the house she's back on the system.

The Mark Levinson 30.5 and 31

Let me stop here for a moment to tell you about this great chick I know. She's really nice and sweet and super smart and has a great sense of humor. She loves sex and cooks and cleans like a professional. She's great, right? Oh ya, by the way, she's 6' 9", weighs 600 pounds and has got a wonderful case of severe acne and lovely greasy hair. Her tragic breasts look like empty hot water bottles and her teeth are a beautiful battleship gray. The Mark Levinson 30.5 and 31 are by a million miles the best looking digital hi-fi gear ever made. "So what?" you say. Listen you phonies, don't give me that looks-don't-count crap... Hi-fi is a hobby and part of the attraction to the hobby is when the gear is so good looking. The Mark Levinson CD stuff is also built like a mother _____

As far as quality and craftsmanship, comparing it to old McIntosh and Marantz gear is a joke and the joke is not on the Levinson. The Levinson is built more in the tradition of companies like General Radio and Western Electric. The 30.5 and 31 are all modern classics. The Mark Levinson digital audio gear is the best sounding CD gear I've heard. Yes, it was better than the supposedly great Denon DPSI DASI that Thomas J. Norton, a.k.a. Big Tom Brown Stain, said was so warm and wonderful. Listen Norton, if you need your digital CD stuff to warm up your hi-fi, you're in trouble. My system is already warm, all warm means with digital is colored sound. Most guys who write about digital audio equipment must have horrible sounding systems. They love the "it's so warm" line. A black man don't need no suntan.

...comparing it to old McIntosh and Marantz gear is a joke and the joke is not on the Levinson.

Yes, my loyal fans, Hi-Fi writing is just passing gas. And you know that only The Gallo can turn that kind of brown gas into the finest perfume.

OK then, I thought that the new Krell MD20 and Studio D/A are very very good sounding and very well made. If there was no such thing as Levinson, I might have bought the Krell. Unfortunately for Krell, there is the Levinson. The Levinson blew away the Goldmund Mimesis D/A and transport. My retard friend who loaned it to me has all the Goldmund gear, always has (fool). I still have never liked a thing from this overrated pretentious company, lay down and die. And the Spectral SDR 2000 is the American Goldmund. Yuck! Forget the Forsell — Forsell-forschmell. And forget the Jadis. Neither sound better than the Levinson. They are both built for trouble, and you can't give 'em away used. Fat chance getting a quick overseas repair. Don't buy foreign computer stuff. Didn't like the Studer or the EMT but the Esoteric P2 is a great transport for you tragic smaller budget guys.

But forget all the Asian built CD stuff. As a matter of fact forget all asian-built products period. Remember companies like Nakamichi, builder of fine cassette players? Well, just five years after the production of their shocking expensive top of the line cassette units, parts were no longer available. Levinson services every single product they've sold since 1972. I'd bet my life in twenty years only Levinson owners will be able to say things like "bought that little honey CD stuff 20 years ago and it still works perfect." Funny the 30.5, 31 and 35 are sold in droves in Japan. Smart rich Japanese don't buy no Sony Panasonic digital crap.

I couldn't wait to hear the Cello/Apogee D/A converter. Too bad it was just OK.
The Counterpoint D/A and transport — just OK looks, nothing special sound, and built pretty cheap. The point about Counterpoint is that there's no point in buying it.
The Theta Generation V D/A sounds very good but the transport was just average. Very good + just average = just above average. Don't play matchmaker with digital gear. It's always better to use a transport and processor designed to work together. Trust me.

A used Wadia 6 is a good player if you're a cheap penny pincher. I talked my cheap penny pincher pal Mark Lyons into one, but when he got it he discovered a problem. Like his idol, me, Mark listens only in mono but D/A outputs are stereo only, they cannot be Y adapted to mono. When I ordered my Levinson I had to ask them to solve this problem for me, so they designed their first D/A mono adapter for The Gallo. It's basically a pair of resistors, simple, right?

Well, a frantic and teary eyed Mark Lyons called Wadia in a huff, talked to their technical gurus, explained his problem. A stumped fellow explained to Mark that nothing could be done. It was impossible, he said. Lyons, tears still flowing said, "But my idol Vinny Gallo bought Levinson and they made a mono adapter for him." The stumped fellow replied, "Oh great, I have a friend over at Levinson, I could call him and ask him how it's done." Wadia has got alot of nerve making a twenty five thousand dollar D/A and transport combination if they have to call Levinson for that kind of technical help.

Plus the 7+9 combination is barely better than the 6 player. Companies like Wadia and Theta change models much too often. Their approach to model changes and upgrades is a bunch of technopolitics that gives digital audio a bad name and makes people scared to invest. They are really just correcting their own mistakes, unlike the two enduring Levinson classics.

I think that digital audio is at the point today where units like the ones from Levinson and Krell are so good sounding that if I like it so much today why should I ever dislike it? It's classic gear. Even if new things came out that sound incredible this gear will always have appeal. A lot of the gear I listened to sounded at least pretty good. I could have lived with several. I just liked the whole Levinson package best. You should see the lid open on that transport! Even the less expensive 35 sounded incredible. It's so great to have both the best CD player and record player in the house. I'm very lucky (. . .lucky my ass, I'm Vinny Gallo).

Great records are great records. I like them most but great CD can crush bad vinyl. Anyway, they are different and for different things. CD is a miracle and should be very celebrated. Come on you children of the tired hippies, let's celebrate the new again and still dig our old. My thrilling CD experience got me to even buy a laptop computer now. I can't believe I lived without one.

I had been buying used vintage hi-fi things for so long it was tons of fun opening the boxes of my Levinson stuff, even their packing is incredible.

I can't believe I have something under warranty, oh my god, 5 years with the Levinson. Now I can kick back and really enjoy the music, just like the people with cheap boom boxes. Before, I was too busy tracking down gear or begging asshole technicians on my hands and knees to take time out from their ego maniac amp designs to fix my gear. Good-bye to incompetent technicians like that inbred Eric, author of the novel "1000 Ways to Tell a Lie," or that hi tech electronics abortionist Nick the rip-off master gimp from N.Y., not to mention wacko Rick Nasty-as-they-come from NJ. Man, I got 5 years from Levinson and it feels good. The last guy to fix something for me was Joe Roberts. I sent him my mintest Western Electric 91 via Priority Fedex. Took him 3 years to finally open the box. If it were Levinson gear, at least I would have still had 2 years left on the warranty.

By the way, I finally heard the Scott Nixon tube unit with his TEAC-based transport, borrowed it. Sounded like an over tubed Realistic. Tubes just color digital audio period but his solid state piece Model TX-ATAX is pretty good. Solid state gear has finally come into its own with digital audio. Scott Nixon sure is a very bright and clever guy, a genius technician and engineer. But Madrigal Audio labs, a.k.a. Mark Levinson, has about 18 genius technical people working there. I even went up to the factory to tell 'em that they done good.

Everyone at Madrigal was super cool and together, the place was phenomenal, not a sour puss in the joint. I got to meet the guy who does all the cosmetic design (I am a fan) plus I got to see where all the metal work, anodizing and engraving is done. The guru who is in charge of that department is a god. It's the best metal work I've seen anywhere. Even the packing and shipping guys were super efficient and organized, not your usual warehouse clowns.

I also met some cool older ladies putting together circuit boards and soldering like they were at a veteran needlepoint convention. It reminded me of those old black and white Western Electric factory photos only these girls were soldering with the help of computers!

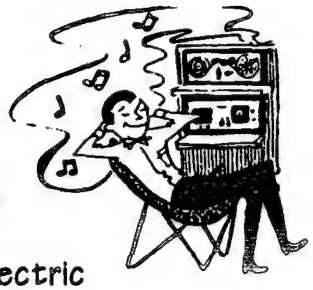
Super nice guy Martin French, Madrigal's domestic sales coordinator who invited me in for a visit, spent hours and hours with me, showing me every part of the whole joint while I pumped him with a million questions and even begged him to describe the last day Mark Levinson was actually there. I also loved meeting my hero technician, the guy who solved my adapter problem by building me a stereo to mono box adapter using some Madrigal RCA jacks mounted on a cool vintage hammertone bud box. The guy's work is perfect, I mean OK, it's just a little mono box, but it's beautifully done. I should be so lucky to have him repairing my Western Electric gear.

But the best thing about the Levinson is that it's brand spankin' new without cigarette smoke stains from the projection booth. I didn't have to buy it sight unseeen over the phone from one of those lying and cheating audiomart small time charlies. It's not rare and irreplaceable and it's not unfixable. I'm not changing no caps inside the thing, instead I'm home on my ass laughing and listening to music.

Hi-end Audio does have a future and Future Boy will be there.



Casual Reactions



by Herb Reichert, Eddy Electric

AUDIO ELECTRONICS SUPPLY SE-1 STEREO SINGLE ENDED AMP KIT

I must say up front that I am not a reviewer by nature. A critic, yes . . . aren't we all? Reviewing always seemed too pedantic to me. Besides, who wants to become a geisha for two-bit industrialists? Beauty, drama, and high level sentiment are far more exciting to write about than the contents of popcorn stuffed boxes. The guys who review for a living have a hard time just unboxing another CD player or DAC. They are probably down before they plug it in or read the manual.

Really, what can you say? It improved MY system? It made it worse? I never heard anyone say "I put the new Super-X in my system and there was *no* change." When I put a new piece of equipment in my system, I am hoping that I will discover some new level of excitement and escape in the privacy of my home. I am hoping that the system will become more enticing and that I will look forward even more to putting a record on. I go to that place between the speakers for escape, fantasy, enlightenment and inspiration. I always hope the new component, especially when I designed it myself, will kick up the intensity level of the listening experience.

However, I promised the editor that I would give the readership some clue as to what to expect if they bought the Audio Electronic Supply SE-1 stereo single-ended 300B amplifier kit. The kit costs only $549 without tubes and $899 with Cetron 300B tubes. At this price, ANYBODY would wonder how it sounds. After all, Shindo sells his 300B single for almost $10,000. L'Audiophile in Paris gets $7000 for theirs, and my own Copper Edition 300B is $5300. Everybody wants to know what, if anything, the big buck amps have on this Adcom-priced directly heated triode amp.

Let me start by saying that what you give up or what you get with this amp or the Audio Note Kit One is directly related to what you have for speakers. Anyone who is contemplating building or buying a single ended triode amp must understand that a SE amp sans feedback *will have a high output impedance.* Additionally, it seems that people are so afraid of losing a couple of watts or burning up a rare or expensive tube that they are using low turns ratio outputs and low plate voltages and low currents. All this adds up to output impedances on the order of 3-5 ohms! With this kind of output Z, power transfer into most kinds of speakers will be anything but linear. Back EMF from the speaker voice coil will not be "absorbed" completely by the amp output stage and "ringing" will result. In other words, the speaker will be poorly damped. Therefore, unless you have a speaker with a benign impedance curve and simple first order crossover (better yet, none at all), you can count on soft, woofy, distorted and indecisive reproduction.

The Western Electric 300A/B has a plate dissipation of 40 Watts. The AES SE-1 uses fixed bias (-67V) and low plate voltage (337V) for a plate dissipation of 23 Watts. This is where it seems many home and professional designers are operating their tubes. They are using 3K primary windings to accommodate this operating point. I would suggest a less fearful approach: try 425V plate voltage, 80 mA plate current, and 5K primary Z. This is still only 34 W dissipation but the output Z is lower and the sound is fast and tight into a few more loads. Triode lovers should have NO FEAR. Triodes can take it.

Operating points aside, with the right speaker, this almost-free SE 300B amp can deliver most of the beauty of the big buck amps. I tried the SE-1 on every speaker I could find and one trait could never hide: the bass was soft. On both small two-ways like the Audio Note AN-K and big full range horns by Altec and Electro-Voice, the bass was a bit on the puffy side. Big deal. The bass is somewhat soft and puffy on almost all tube amps. When you don't use negative feedback (the SE-1 has no feedback), you must forget about really tight bass. With 7 watts, low current, and high output Z, there isn't a speaker out there that can save you in the low end.

On the other hand, the midrange beauty and the gentle but forward highs couldn't hide either. No amp plays all ten octaves perfectly and the SE-1 is no exception. It's strengths are definitely found above 150 Hz.

I measured an output Z of 4.2 ohms at 40 Hz and 10 KHz. Those are the frequency ranges where most speakers present low impedances, very often below 4 ohms. Baaad! Evil! Damping factors of less than one make us sad and despondent. This is why "they" invented feedback. It is really too bad that feedback is such a fun killer because it sure makes some things easier.

I can hear your wheels turning as I type: "These guys should not be so dogmatic about no feedback. Why not just throw in a few dB of NFB to lower the distortion and output Z?" That's exactly what I was thinking. In fact I was about to give it a try when I measured the input sensitivity at 1.3V for full output (8W). Adding even 3 dB of NFB would bring the sensitivity down to 1.8V and 6 dB would get us over 2.5V. This is too low for my system and too low to use with a CD player direct in. So let me get off this low output Z stuff (for a while) and get to the good stuff. Didn't I say that reviewing was pedantic?

So now that I have convinced you not to drive your WATTs with the SE-1s, I am going to tell you about a few speakers that it drives very well. The first speaker I tried with this amp was the good old Western Electric 755. Presentation was a pinch mellow but very very charming. The old Frank, Nat, and Julie trio was completely seductive. Jazz material was transparent, quick, and harmonically rich. I still recommend a 2A3 push-pull amp with this speaker, but I believe many readers would be very happy with the 755/SE-1 combo. This speaker showcases the amp's strong points and minimizes its weak points.

The Audio Note AN-Ks, smallish two ways with outstanding midband coherence, worked very well and played at generous SPLs with the SE-1. These amps clip *very* gracefully but when they are pushed too hard, the frequency extremes began to become a bit distracting. I personally can listen around this kind of thing and I usually do. Recovery of hall sound, reverberation, and ambient information, precise location of players, musical body, and authenti-

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cally scaled soundstages can be expensive qualities to come by. They are luxury stimuli. However, you can get them with the SE-1 without a trust fund. Using the SE-1 above 150 Hz and a high quality push pull amp to drive the bottom should get you into the jet set audio club on a budget.

This amp has a near world class mid, upper mid, and lower highs. I have never heard this much beauty in this range for anywhere near this price. However, triodemania requires strong will and good taste. The SE-1 owner must choose his speaker wisely. The amp played the BLISS system (see *SP* 2:1) full range with plenty of power and the beauty level was such that I could listen entranced. However, the SE-1's flaws were very obvious on this setup. I mentioned the bass and the output impedance, but the biggest problem shows up very clearly on the scope: slew limiting! This thing just doesn't get the leading edge of transients. This soft attack is offset by the amount of overtone structure it appears to present. Now remember, the reason we all sold our 5K$$$ solid state amps is that we wanted to recover harmonic structures that we felt were missing. So we should be kind, but the leading edge *is* where the excitement lives.

First thing I discovered in bench testing — listen up all you tweaks, modifiers, and never leave good enough aloners — the output trans are very good. Full power bandwidth was 1 dB down at 20 Hz and 3 dB down at 28 KHz. Phase shift below 100 Hz was very well controlled. Ultrasonic behavior was also good with no sharp peaks or obvious ringing.

The next best thing I saw on the bench was the overload character this amp demonstrated: Gentle, symmetrical, and deep. This amp is like the Duracell bunny; it just keeps going and going. There is plenty of A2 voltage beyond the 8 Watts I measured at clipping. You don't want to know what some of this voltage looks like but its there if the Melvins or Biohazard need it.

Honestly folks, the SE-1 tests about as good as can be expected. This kind of amp is designed for beauty of sound rather than good bench results. I personally spent more than two years listening to a 300B single with an almost identical driver stage. It was a monoblock design with Tango iron and Black Gate caps. It sounded pretty much the same as the SE-1. I recognized its faults but kept it in my system because it just played all my records. Then I came home from work one day and wanted more excitement. . . and so the story goes.

I saved the best news for last (we are near the end, right?) The last setup I tried the SE-1 in was the big winner. Remember how much I liked the Edgar mid-horn with the D-54? In the BLISS system set up for biamping, the SE-1 drove the Edgarhorn/PR-120 combo to perhaps 80 or 90% of the quality level of my own Silver Single. Maybe even better, if you correct for author-bias effects! Either way the Reichert amp has $2500 worth of Tango, Black Gate, Kimber Silver, and Audio Note silver caps. So what do you want me to say, that this $900 amp beats the best that I have heard? Maybe it does. Next issue I will tell you about the Audio Note Kit One, another 300B SE stereo amp. In the meantime, try the SE-1 with the Altec 601 or 604 coaxials, the Goodmans Axiom 80, the JBL LE-8T, the Focal 7V, or ????? Sweet dreams.

Manufacturer's Comment—
Audio Electronic Supply

One can just imagine the astonishment a designer and manufacturer would feel when one of his designs (i.e., babies) is about to come under the eye of a dispassionate competitor. I must admit that when I received a call from Herb Reichert with a request to review the SE-1, it was like a bolt out of the blue. I mean, Herb designs and manufactures his own 300B amplifier. . . that guy is a competitor!

As my mind went into that state of momentary apprehension, shouting inaudible words like vulnerability, conjecture, and mistrust, out of my mouth came phlegmatic, cool, and composed words. I came to realize that I am not building castles in the air — the SE-1 is a real-world amplifier and deserves to come under ethical examination by another talented designer.

After reading the review, I am honored and pleased that Herb Reichert gave Audio Electronic Supply the opportunity to share his critical assessment of the SE-1. It put a smile on my face. I must say that the joy of reading about one of my designs goes beyond the SE-1 itself. The true pleasure came with the knowledge that the audio community is being informed and educated about the incredible merits of listening to music through single ended triode vacuum tube amplifiers.

First and foremost, the SE-1 was brought to market to offer an accessible entry to the glorious, sensuous music reproduction of single ended triode audio. As with any product, there are strengths and some weaknesses. The price class of the SE-1 is certainly a salute to the single ended triode movement. Second,

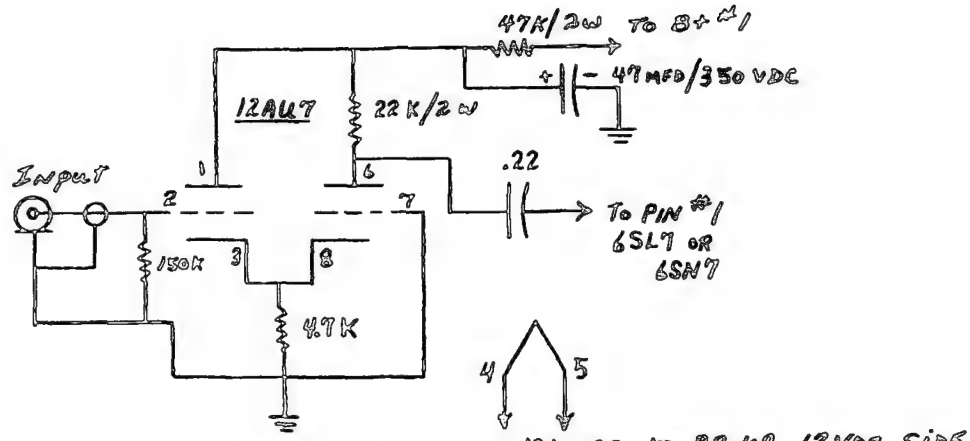
the SE-1 is FUN. FUN to listen to, FUN to build, and FUN to tweak and modify.

In response to Herb's comments I developed a circuit to boost the input sensitivity of the SE-1. I call this a pre-driver. The addition of this buffered grounded grid amplifier circuit will present the user with a number of options:

a) Add pre-driver stage and increase the input sensitivity of the SE-1 to 350 mV drive for full output.

b) Replace the ground lead from pin #7 of the 12AU7 (grid) with a 1K 1/2 watt resistor to ground. Add a 22K 1/2 W resistor from the positive speaker output to pin #7 of the 12AU7. This will yield 3 dB of global feedback. (I never dreamed that I would instruct the world on how to add feedback to one of my SE triode designs!)

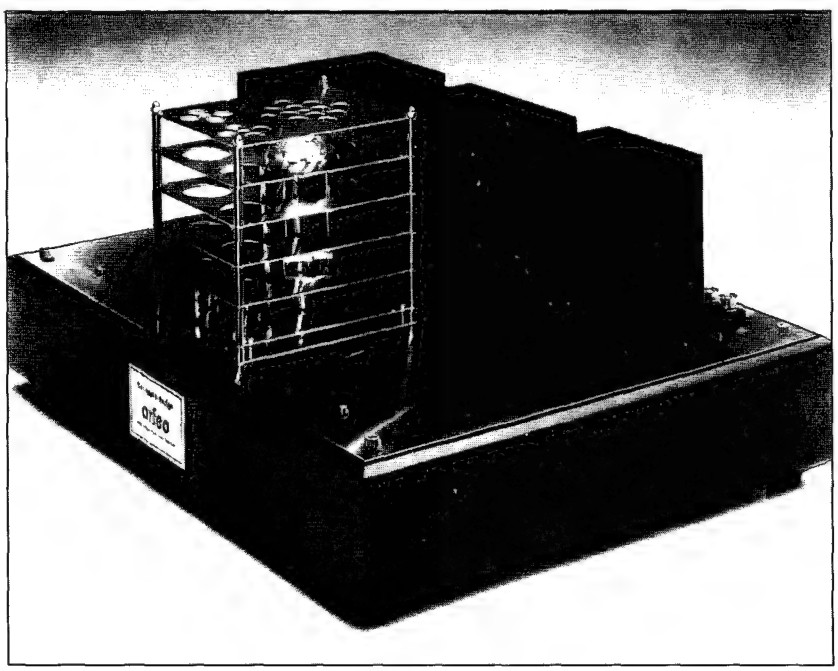
c) Add the pre-driver stage and remove the 500mF/2mF AC bypass cap combination on the cathode of the 6SL7. This will add current feedback to the 6SL7 and still yield a 750 mV input sensitivity for full output.



SE-1 Predriver Stage D-TH 8-15-94

d) Here is the best option of all, in my opinion: add the 12AU7 pre-driver with the grid directly grounded (pin #7 to ground, no feedback) Remove the AC bypass caps from pin #3 (cathode) of the 6SL7. Change to a 6SN7 low mu driver tube in place of the existing 6SL7 SRPP driver.

The last option simply sounds explosive. The 12AU7 circuit provides the front-end gain required for the lower gain 6SN7 low mu triode. The plate resistance of a 6SL7 is on the order of 44,000 ohms as compared with 6700 ohms for the 6SN7. With the cathode current feedback and a much lower plate resistance, the 6SN7 delivers drive in spades to the grid of the 300B. The input sensitivity of an SE-1 with option D is 1.3 V for full output — adequate sensitivity for CD players direct in. Most active preamplifiers will have tons of drive for this circuit.



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Let's take a closer look at the pre-driver circuit. The first section of the 12AU7 is a simple cathode follower buffer, direct coupled to the cathode of the second section. The second section acts as a linear grounded grid non-inverting amplifier. In fact, the entire stage in non-inverting. This circuit can be useful in many applications. The AES AE-1 preamplifier utilizes this arrangement for the input and gain section with a few changes. Direct couple the plate of the second section to the grid of another follower-buffer stage and you have the makings of a respectable preamplifier. Another good use for this straightforward buffer/grounded grid pre-driver is as an amplifier for low output moving coil cartridges.

The mechanical placement of the two 12AU7 tubes on the SE-1 chassis is very convenient. Use a 1/2" hole punch (Greenlee or similar) and center the holes on the same lines as the 6SL7s. The center of the hole for the new 9 pin socket should be 1.5" out from the center of the existing 6SL7 socket.

I would love to hear from folks about various modifications for the AES SE-1 single ended amplifier. This guy is perfect for the avid homebrewer with an appetite for experimentation and tweaking.

Dennis J. Had
Chief Tube Polisher
Audio Electronic Supply

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Development of a 211 Amplifier

Part 2: Shunt Regulator Concepts

John Camille, Chimera Labs

SHUNT REGULATOR OVERVIEW

Many thanks to all the *SP* readers who wrote or called in response to the first installment in this series published in *SP* #4. Since the publication of that article, we have been overwhelmed with questions regarding shunt regulator implementation in our 211 amplifier. By way of response to these queries, I decided to pull the shunt regulator discussion forward to this installment.

Our decision to experiment with shunt regulators began with a hunch rather than a calculated rationale. Marsh in *TAA* [3/83, 1/88] found that shunt regulators sound better than series pass regulators. His work focused on low voltage transistor amplifiers but it seemed to us that the concept held promise for high voltage tube circuits.

In loose terms, the theory is that shunt regulators can both source and sink signal current whereas a series pass element can only source supply current. When properly applied, a shunt regulator should have the same impedance, hence equal slew rate, for both positive and negative slopes of the signal. A primary design goal for this regulator was to make it very much faster than the regulated circuit. Consequently, slew rate limitations become a non-issue and improvements in the transient response of the entire system are realized.

Our shunt regulator is optimized for AC response in the pass band that extends one decade outside the audio pass band, i.e. 2 Hz to 200kHz. This extended pass band allows for excellent square wave response for audio band signals. In other words, transient response is more than adequate for the relatively slow audio signal repertoire.

DC response is relatively slow as dictated by the long time constants within the servo loop. Long term DC voltage drift is several volts (< 1%) as dictated by the thermal characteristics of the reference diode and the voltage divider components. Since DC plate voltage drifts of 10% or so are permissible, the regulator circuit is more than adequate in this respect. The overriding requirement for this device is to provide a low AC impedance (AC short), not to provide a DC voltage standard. Thus, the term "regulator" is somewhat misleading in light of its primary function. The term "Nifty Electronic Audio Terminator" and the resulting acronym might be more appropriate.

One critical benefit of the shunt regulator topology is that it provides an extremely clean ground return path for the signal. This is crucial in single ended amplifiers where the entire signal return path runs through the power source and associated filter and bypass capacitors. The shunt regulator essentially places a short circuit for AC across the circuit with several immediate advantages:

1 — Unlike enormous bypass caps, the regulator presents a constant, low impedance across the audio pass band. Phase shift is a constant at all frequencies and all of the signal developed by the regulated circuit appears across the load.

2 — Power supply crud is shorted to ground, enhancing signal purity.

3 — Coloration of the signal by power supply components is reduced to a minimum. The effect is better than bypassing with thousands of microfarads of teflon quality capacitors.

4 — Above all, the return path, aside from being "short and sweet", is controllable. The "sneak" return paths found in series regulators are also eliminated.

Basically, the signal return path through the shunt regulator tube is about as clean as you can make it. Trace the ground return path through your favorite series pass regulator in comparison and you will see what I mean!

THEORY OF OPERATION

Figure 1 depicts a rudimentary form of shunt regulator for a tube load. The shunt regulator element in this instance is a rheostat placed in parallel with the load. If the rheostat is adjusted so that the resistance is equal to that of the tube, in this case 20K, the two parallel resistances combine to form a 10K DC

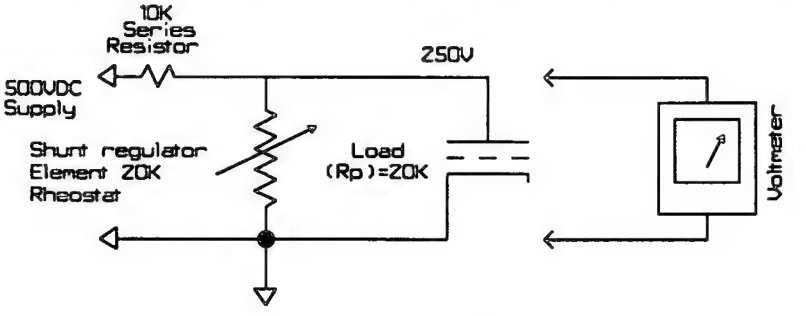


Fig 1 — Concept of a "mechanical" shunt regulator

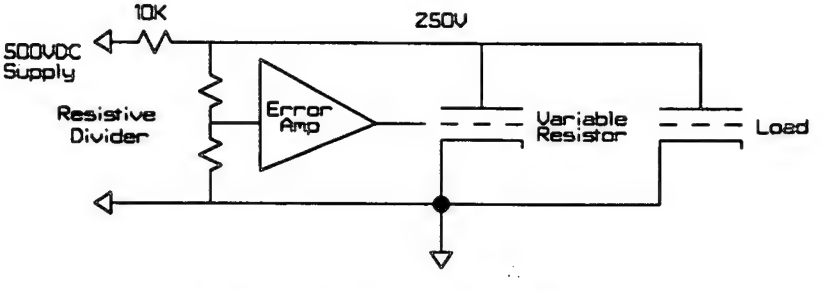


Fig 2 — Simplified electronic shunt regulator

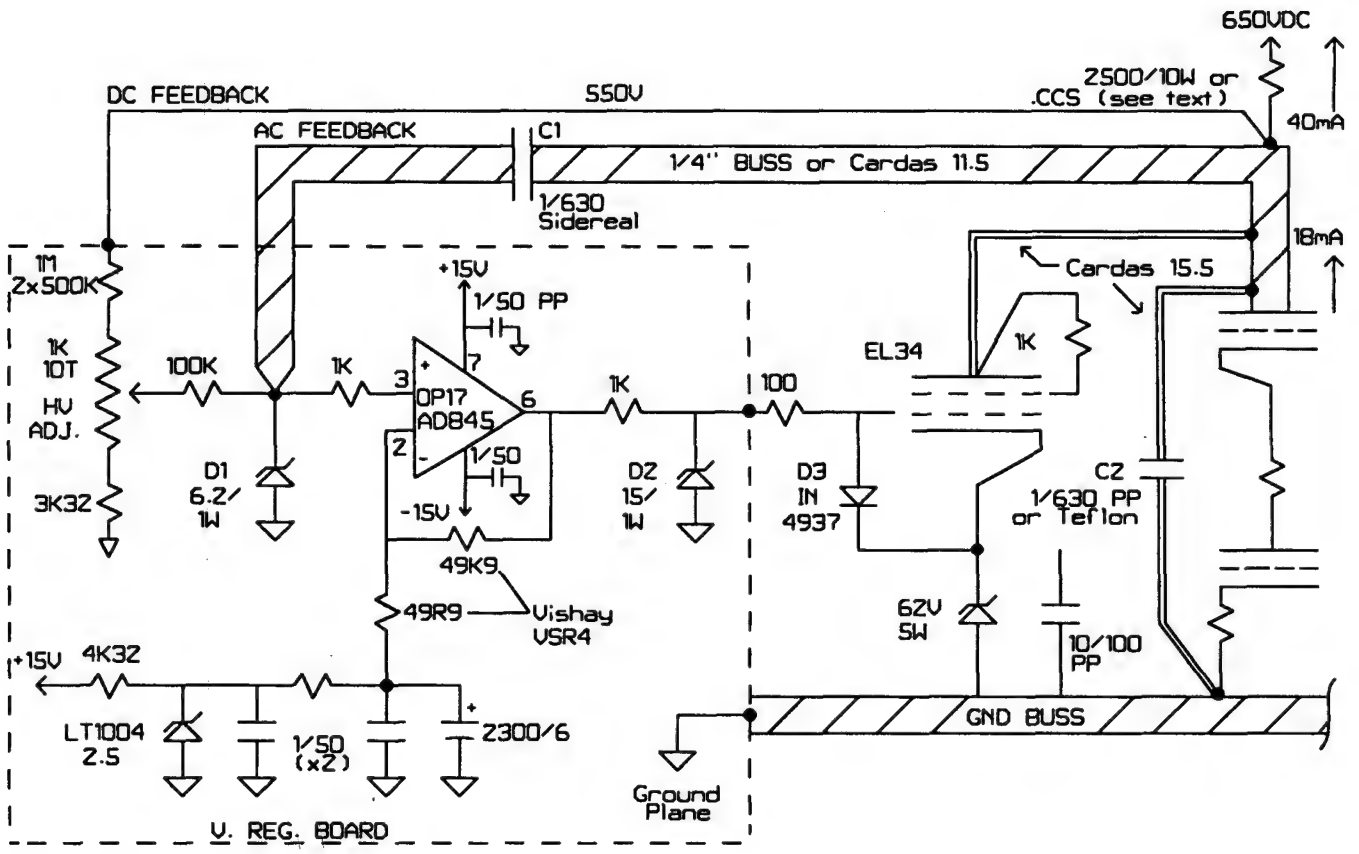


Fig. 3 — Practical HV shunt regulator

resistance. Since the series resistance is also 10K, the 500V supply voltage is divided by two. Hence, 250V appears at the plate of the tube.

A human operator could occasionally check the tube's plate voltage and manually adjust the rheostat so as to maintain the desired 250V potential. In this way, the tube's plate voltage is regulated, albeit slowly, by the human operator — who can be called the *error detector*.

This regulator circuit works fine if adjustment is required infrequently. For audio, we need to speed up the operation so that the rheostat can be adjusted several times a second. We need something that responds very much faster. Since a vacuum tube is essentially a variable resistor, let's use a tube as the shunt regulating element. Of course, other variable resistors such as transistors or MOSFETs could also be used. By varying the tube's grid bias, we can control its plate resistance, *rp*, at speeds up to tens of millions of times per second.

The human error detector can be replaced by a kind of voltmeter circuit that can be used to drive our regulator tube grid rather than a meter movement. This detector/amplifier is called an *error amplifier*. It should be wired so that any deviation from 250V causes a corresponding change in the tube's *rp* in the direction which restores the 250V equilibrium.

Figure 2 shows the layout for this faster configuration. A resistive divider is placed across the 250V buss in order to provide a sample of the voltage to the proper range to operate the regulator tube's control grid. Changing grid voltage produces a change in plate resistance and the resulting change in plate current counteracts the undesired change in plate voltage. Another way to look at it is to consider that varying the plate resistance of the tube maintains a constant current through the 10K series resistor so that a constant 250V drop occurs across this resistor.

The dynamic resistance of the tube can be made very low by increasing the gain of the error amplifier. Infinite gain would produce a zero impedance to AC signals. Therefore, for our theoretical example, we have a device that has a 20K ohm resistance to DC current flow and an infinitely small resistance to AC current flow.

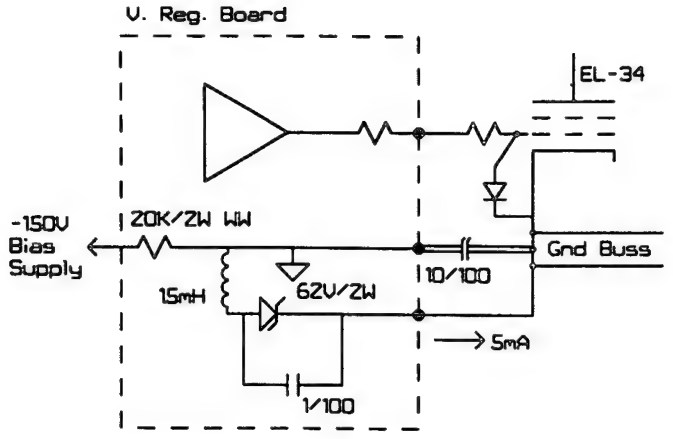
The greatest disadvantage of the shunt regulator is that the regulator's quiescent current draw must equal or exceed the peak current swing of the regulated stage. This operating point permits the regulator to effectively source current to the regulated stage during positive signal values. During negative signal values, the regulated stage's plate voltage would tend to increase as the current decreases. Under this condition, the regulator must sink appreciable current in order to maintain a constant plate voltage.

The conceptual circuit of Figure 2 must be modified extensively to make it work in the real world with available tubes.

PRACTICAL SHUNT REGULATOR

Figure 3 shows a practical shunt regulator that is fairly easy to implement. It was one of our first attempts at a regulator for our 211 amplifier. This circuit can be mounted on a small puddle board mounted directly on or immediately next to the EL-34 socket. The ground plane of the board should be connected to the mu-follower ground with a 1/2" wide copper strap, the shorter the better. The AC feedback capacitor (C1) should be connected directly to

Fig 4 — Revised bias arrangement.



the plate of the mu-follower. If zero lead length is not possible for this capacitor, use 11.5 ga. Cardas wire or a 1/4" copper strap.

CIRCUIT DESCRIPTION

The 2500 ohm series resistor provides the voltage drop for the shunt regulator to "work against." It becomes a 40 mA current source as it drops 100 VDC below the 650V supply.

The voltage divider provides approx. 2.5 VDC to the error input of the OP17 (pin 3) through a 100k resistor. The 100k resistor isolates the DC and AC feedback paths such that the AC feedback is almost unity down to about 3 Hz. Otherwise, the AC feedback would be shorted through the low resistance between the volt adjustment pot wiper and ground. The 1 uF/100K combination plus the 1 meg divider resistor provides a very long time constant integrator for the DC feedback path.

The AC feedback capacitor (C1) transmits voltage variations at the mu-follower plate directly to the non-inverting input of the op amp through the protective 1k resistor. This error voltage is amplified 1000 times by the op-amp and applied to the EL-34 grid through a protective network. The error voltage is further amplified by the EL-34 which has a gain of about 10.

The theoretical dynamic resistance of this system should be around the plate resistance of the EL-34 divided by the system AC gain of around 10,000. Actual resistance measures about 0.38 ohms. This number is more meaningful in practical terms when you consider that it is equivalent to a bypass cap of over 40,000 uF at 10 Hz!

The LT 1004-2.5 provides a precision 2.5 V reference for the system. Diodes D1, D2, and D3 provide HV fault protection for the op-amp. The 62V zener provides grid bias for the EL-34. Capacitor C2 rolls the system off to prevent high frequency oscillation.

During full power operation (150V p-p), the error hunt band plus noise of the system is less than 250 uV, measured at the mu-follower plate. The error voltage to the EL-34 grid is approximately 250 mV peak-to-peak. This error voltage waveshape should be the inverse of the mu-follower's output signal plus a large component of noise and possible 60/120 Hz hum.

REGULATOR ENHANCEMENTS

Various changes to the shunt regulator evolved during listening tests. When we decided to go "whole hog" with the 211 output regulator, it was necessary to float the error amplifier so that the 211 regulator filament could be tied directly to the 211 amplifier filament. Thus, the error amplifier board (ground plane) was floated at the nominal grid bias for the regulator tube involved. The EL-34 based regulator for the input stage was also changed to a floating configuration.

When we tied the EL-34 cathode directly to the ground buss, a detectable improvement in sonics occurred. We attributed this effect to the removal of the 62 V zener from the signal return path. The revised bias arrangement is shown in Figure 4.

The 211 HV shunt regulator circuit uses the same topology. The voltage divider and the AC feedback capacitor must be sized for the increased plate voltage and the 62 V zener which provides bias voltage must be increased to 75V.

MOSFET REGULATOR

The MOSFET is well suited to shunt regulator service. Performance is sonically the same as the triode version while dynamic impedance can be made slightly lower than the tubed version. The major problem, however, is calming the circuit down. VHF RF wiring and layout techniques are mandatory to prevent parasitic oscillations at frequencies up to several hundred MHz. A fast 100 MHz or better scope will probably be needed to "debug" the circuit. Zero lead length layout technique on a ground plane is the best way to go.

The MOSFET regulator is slightly quieter than the tubed version since the error amp can be placed at ground potential. Gate voltage swing is only a few millivolts around the 3.5 to 4 Volt quiescent gate bias level. Leave room for a fair sized heatsink if you're thinking of installing the MOSFET version of this regulator.

The voltage divider network for the MOSFET regulator has been upgraded from the brute force network shown in the tubed version. The new version is a knock-off of a scope probe that permits the use of much smaller HV caps. The 211 amp can then use a short piece of teflon coax as the HV cap (C1), using the inner lead as the HV lead and the shield as the LV lead. Thus, a wonderfully cheap, high quality cap is created. Near perfect compensation can be obtained by sliding the shield along the inner conductor to find the exact value for good square wave response, then cutting the cable to this length.

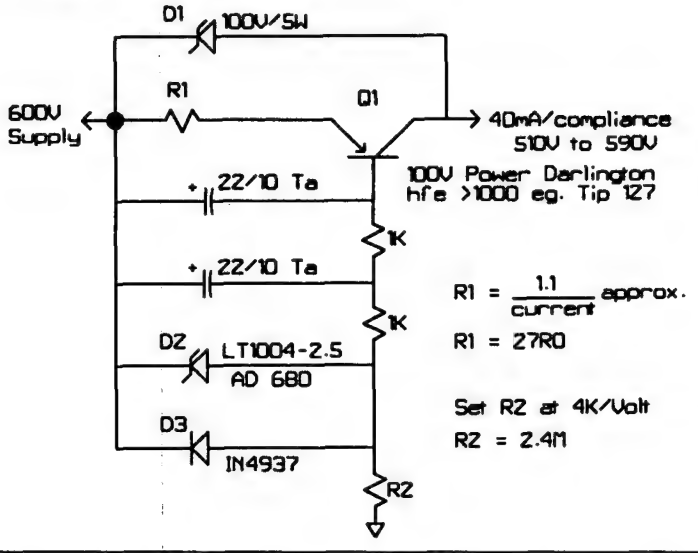
The Collmer 2SK951 (Allied # 925-0930) is rugged and dirt cheap at $1.67 and it is tailor made for this application. One of these devices withstood every imaginable abuse during prototyping and debugging experiments. Overall, this fine part is a welcome departure from my usual experience with high voltages and "three-legged fuses".

Many types of reasonably priced surplus "switcher" MOSFETs are available for lower voltage supplies. The beauty of the MOSFET is that the gate bias is always around 4 Volts — ideal for op-amp drive to virtually any power MOSFET available.

CONSTANT CURRENT FEED

The series dropping resistor (2500 ohms in Fig. 3) may be replaced with a constant current source (CCS). This change provides much greater isolation between the regulated stage and power supply nasties. Equivalent series resistance can be made to equal several tens of thousands of ohms.

Fig 5 — Universal Constant Current Source



Voltage drop across the CCS can also be made much smaller as appropriate for line voltage variations. The 211 amp is being designed with an export market in mind so line voltage variations of 110 V to 130 V must be accommodated. This 18% variation in line voltage translates to a variation of over 100 V in the HV supply to the regulated stage. Therefore, the 211 CCS must be capable of holding off the voltage variation and it must be heat-sinked in order to withstand maximum line voltage input, i.e. 130 VAC.

The CCS itself needs only a few volts to function properly. Therefore, a voltage drop of 10 to 20 Volts across the circuit is feasible if line voltage variations are minimal. The lower voltage drop eases heat sink requirements considerably.

It is a definite advantage to use soft-start techniques with this circuit. Otherwise, the pass transistor's hold-off voltage must be equivalent to the voltage input (i.e., at least 600V in fig. 5) because the full power supply output voltage will appear across the pass transistor at turn-on before the down side capacitors are charged. Unfortunately, high-voltage transistors with suitable gain (hfe) are very costly and hard to find, therefore a soft-started power supply becomes even more attractive. A complete soft-start circuit can be assembled for less than $20 with surplus parts and it will more than double the life of all the amplifier components, including tubes. Soft-start is the way to fly.

A universal high-side constant current source is depicted in Figure 5. It will work with voltage differentials between 10 and 100 V. The current capability is determined primarily by the heatsink provided. When the bias resistor R2 is sized at 4 Kohms per Volt, base drive starvation will occur at somewhere between 0.25A and 1A, depending on the hfe of Q1.

NOTES:

1) R1 = approx. 1KΩ/Voutput (Caddock MK).

2) The ratio of C1/C2 should be slightly greater than the ratio of $\frac{2.5k}{R1} \rightarrow \frac{C1}{C2} \geq \frac{2.5k}{R1}$. This overcompensation insures highest speed without using a variable capacitor for perfect compensation.

3) Parasitic suppression resistors must be soldered to the MOSFET leads where they exit the case. Resistor lead length must be zero. Watch ESD, etc.

4) Lower voltage MOSFETs may be used for lower volt supplies.

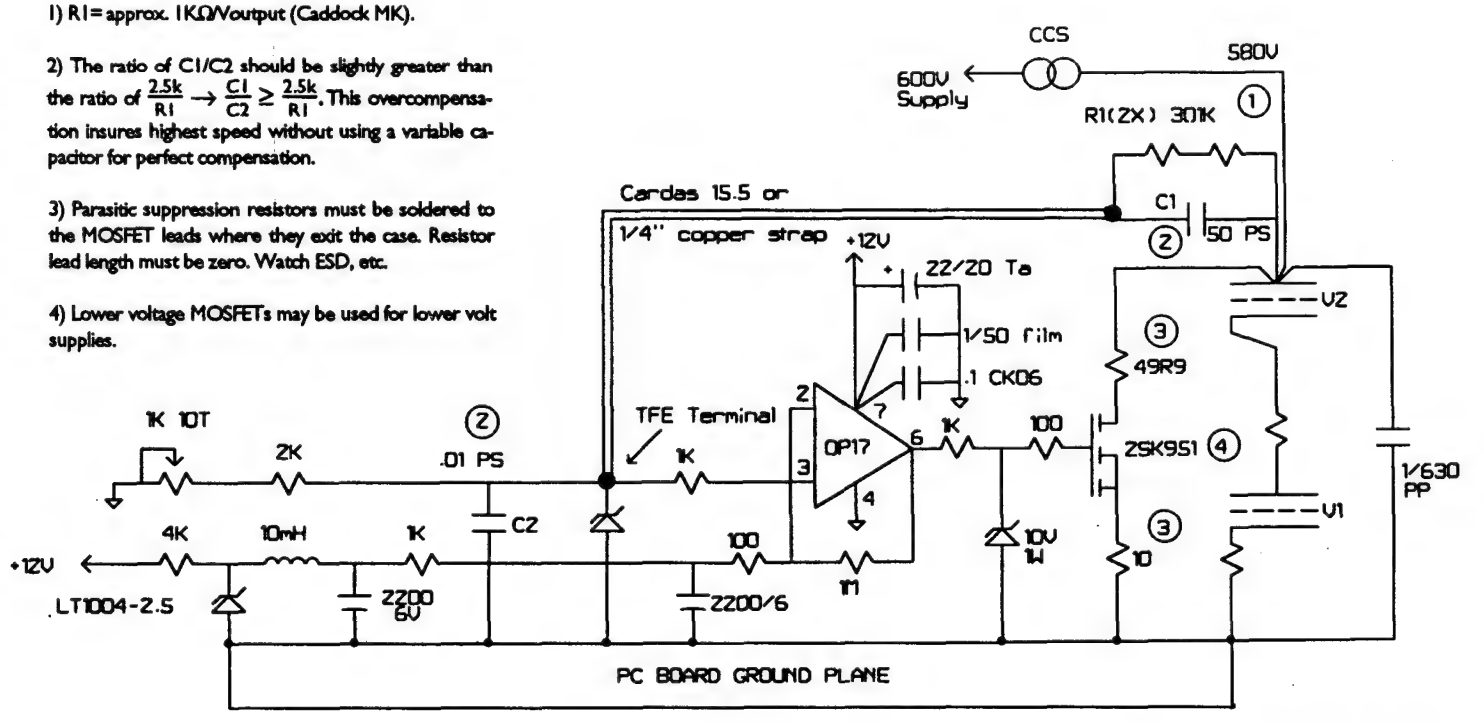


Fig 6 — MOSFET Shunt Regulator

The current set point of the pass transistor is determined by varying the value of R1 according to the approximate formula:

$$R = \frac{\text{V ref} - \text{2 diode drops (w/darl. pr.)}}{\text{Desired } I_0}$$

For our example—

2.5 - 1.4 / 0.04 or 27.5 ohms @44 mW
(use 27R0 / 0.25 W).

Exact current settings may be established by paralleling a 500 ohm ten-turn trim pot with a suitable fixed resistor, 30.1 ohms in the above case.

This CCS has several additional complexities rarely seen in typical power supplies. Diodes D1 and D3 are protective devices for various fault conditions. The RC filter between the zener reference and Q1's base attenuates zener noise that would otherwise be amplified by Q1. The slight decrease in dynamic performance caused by this filter is more than compensated for by the 15 to 20 dBV decrease in noise.

POSTSCRIPT

Based on our listening experiences, we are beginning to feel that the quest for higher power may be misdirected in this niche of the audio realm. Several times we put a scope across the output of the 211 amps while visitors auditioned their music of choice. Edgar horns (106 dB/m SPL) and other experimental tractrix horns (100-106 dB/m SPL) were used in a theater size room. We found that "normal" listening levels rarely required peak output levels over 400 mV p-p into 8 ohms. One associate, the leader of a rock group, preferred to listen to his CDs at about 4V p-p, well over my pain level threshold.

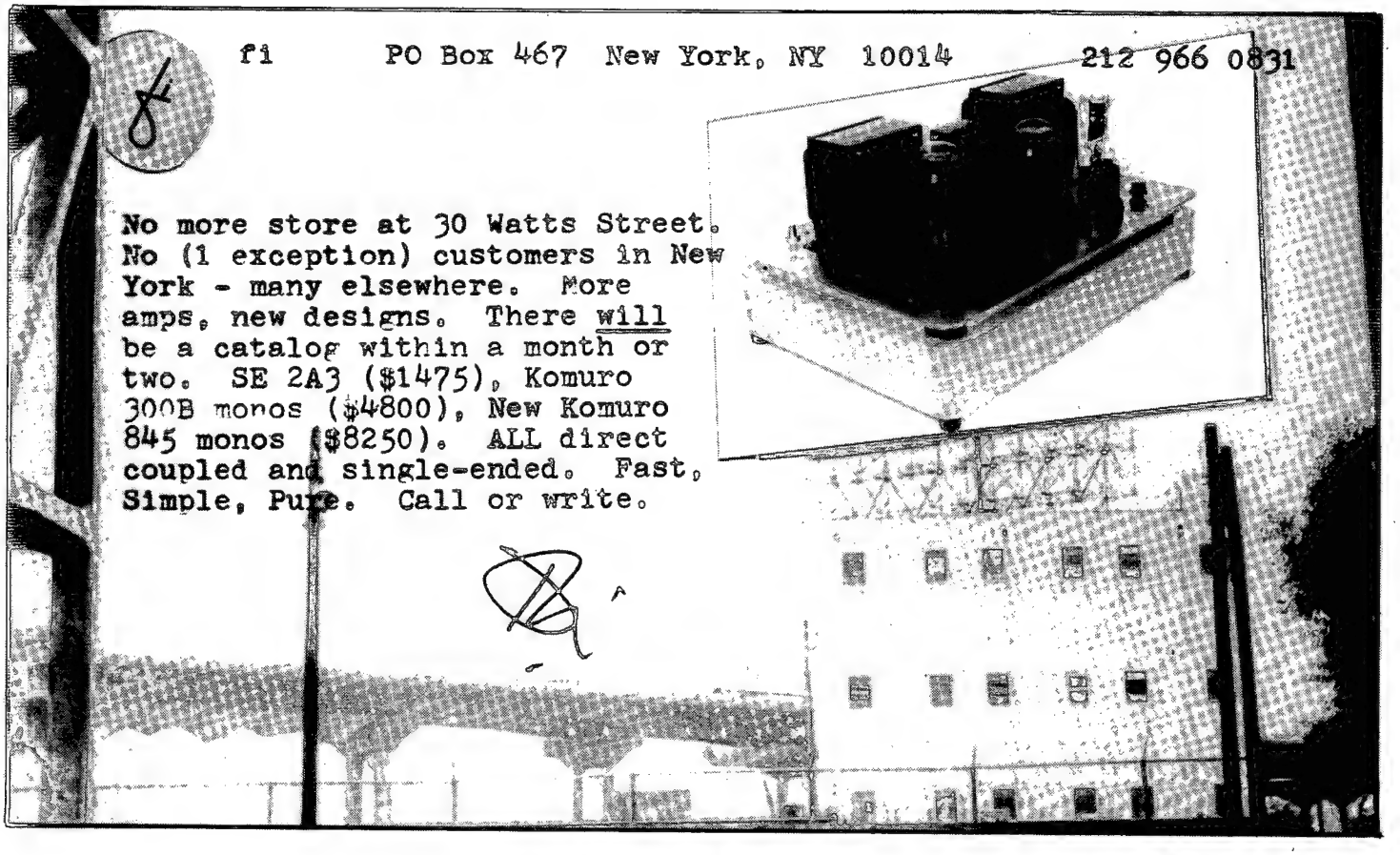
These voltage measurements translate into *peak* output power levels in the 5 mW to 500 mW range. Therefore, a half watt of power provides eminently listenable sound with the kind of horn systems we have been using. Extrapolating from this data, speaker systems with sensitivities in the 88-90 dB/m SPL can be powered with a 211 amplifier with reasonable overhead.

Several low efficiency speakers and ESL systems were auditioned with our 211 amplifier with mixed results in our room. Although the speakers could be driven into break-up, their output was lost in the theater sized listening space. Yes indeed, highly tweaked industrial horns and modern tractrix horn systems can definitely spoil you with their dynamics. When your system is set up in a theater, horns are the only way to go.

Several listeners have remarked that the 211 amplifier is "too accurate". Poor recording techniques, artifacts of the cheap ICs used in the recording chain, and noise in general are more readily apparent than on their home systems. We believe that many nuances not audible on a typical system with a dynamic range of 60 to 70 dBV are revealed when the dynamic range is increased to 90-100 dBV. Most folks relish the difference immediately, some take a while to adapt, and some will never adapt!

High efficiency horn aficionados are particularly impressed with the dynamics of the system. With such speakers, the 100 dBV dynamic range of the amplifier can be most effectively put to use. The 20 or 30 dBV increase in dynamic range gained through a very low noise floor is vividly apparent through a good horn system

We obtained this very low noise floor by going to extremes in providing extremely pure DC to the tube elements in the 211 amplifier. We will explore noise reduction techniques in general, and diode hash removal in particular in future installments of this series.



THE CHORUS

A multivocal tube output stage for your "DAC In The Box"



by Mike Vans Evers

The Chorus is a vacuum-tube output stage conceived as part of a project to upgrade the Audio Alchemy DAC-in-the-box (DITB). There are nearly 15,000 units of this famed budget king DAC in existence which makes it an attractive candidate for a modification.

The sound of the DITB is extraordinary considering its price. Hundreds of hours of development time were spent making the most of the inherent resolution of the DITB and sonic flexibility of the Chorus output stage. I have been working on this project with Don Hillebrand of Wavetrace Technologies. Don worked with Stan Warren on the solid state mods while yours truly handled the tubes. The photo shows a complete Chorus/DITB as available through Wavetrace Technologies.

Wavetrace Technologies (Don Hillebrand) has been doing mods to Audio Alchemy products like the DDE for about two years. Modifying new equipment usually voids the warranty. When Don modifies Audio Alchemy products the warranty remains in effect — a good reason to let Don do the mods, and what I recommend also.

I consider this project to be unique in that special techniques for adjusting the tonality of the final product are employed in the design and a few are available for adjustment by the end user. Most designs address only a few of the areas affecting tonality. This design takes a slightly different approach to the Audio Energy Paths (AEP) that exist in audio equipment. These energy paths are both electrical and mechanical. As I see it, these energy paths have natural groupings: #1 Signal Path, #2 Power Supplies, and #3 Structural Resonances.

In this article, I will share the circuit for the Chorus output stage. It is ideally suited for the DITB but it can also be adapted to a multitude of purposes where a unity gain buffer is required. I will also discuss a few other aspects of the design that deal with AEPs and affect tonality.

A few definitions are necessary in order to follow the text:

Audio Energy Path (AEP): All mechanical or electrical energy entering or leaving a device used for recording or reproducing music does so along a conduit or path. These paths can be electrical (through wire, bus bars, etc.), or mechanical (transferred through the chassis, feet, etc.).

Transient Impedance: Music is a series of repetitive transient energy variations. The resulting frequency dependent variations in current are audibly affected not only by standard yardsticks (resistance, capacitance, inductance), but by some other quality. I am going to call this quality, which affects tonality but not frequency response, "transient impedance." If you don't like my term, make up your own. One example firmly establishes the existence of this elusive quality, at least in my mind: production models *do not* sound like the prototype did!

Listening Skill: Some differences in any two like items, of musical nature or not, won't be discernible except to experienced listeners (tasters, drivers, players, etc.). Hearing a difference but not realizing its significance usually translates into *not* hearing a difference. Learning how to recognize differences in two components is a function of training, experience, and desire. Listening skills can be limited by bias. Those people who "know" without experience may never learn.

AEP #1: The Signal Path
The Chorus Tube Output Stage

"Voicing" a product often takes a manufacturer as much or more time than does its basic engineering. The Chorus is a unique output stage with many "voices" designed to be user-friendly. There are two sockets for twin triodes on the Chorus and they are wired so that one section of each tube is in each channel. You can plug around 70 different tube types from a wide variety of manufacturers into the Chorus and explore an amazing number of combinations. Each combination produces its own voice, the sound being dependent on the type and manufacturer of the tubes in play.

Because of an additional design feature, the position of the two tubes is important. Swap the position of the tubes front-to-back and you have yet another voice. So if you have three tubes on hand, instead of only three combinations, you get six! I recommend that you use both sockets, but the "purist" can choose to use only one tube. If you count in the two possibilities per single tube, a collection of three tubes gives you 12 different voices. Rather than insisting on a "one size rarely fits all" sound, this unity gain output buffer has many possibilities.

No strange biasing schemes are used for this unusual cathode follower, just an ordinary self-bias resistor. This output stage is composed of two dual-triodes, with a half-

section of each tube in each channel. The two dual triodes used can be identical or completely dissimilar, e.g., a Telefunken smooth plate 12AX7 and a Chinese 12BH7.

My current favorite tubes include 12AT7s, 12AU7s, and 12AX7s and 5965, 6414, or 12BH7s. In my system, I use a lower current tube, often a Gold Dragon 12AX7, in the back position and a higher current tube in the front position. Tubes made in China are often brighter, relatively speaking, than tubes made in other countries. As a general rule, 12AU7s have more weight in the bottom end than 12AT7s and 12AX7s. If the harmonic balance of a system is lightweight, I'll usually start with a higher current tube in the back position, say a 12AU7, and use a 12AX7/AT7 in the front position. For overly detailed systems, try to avoid using tubes from China and use higher current types (5965, 6414, 12AU7, 12BH7, etc.), especially in the front position.

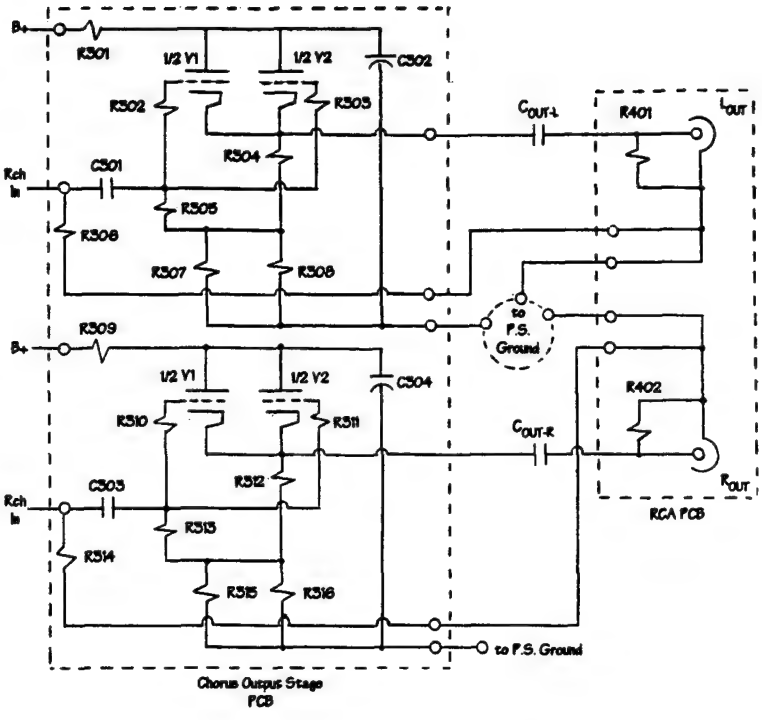
Some suitable tubes for use in the Chorus

Common types	Not so common types
12AT7 / ECC81	12AV7/5965
6201, 6679, 7728	12FV7
	6211
12AU7(A) / ECC82	6414
E82CC, ECC802/S,	6829/E180CC
5814, 5963, 6067,	12AD7
6189, 6680, 7318,	12AZ7
7730	12BZ7
	12DF7
12AX7(A) / ECC83	12DM7
5721, 5751, 6057,	12DT7
6681, 7025, 7729	12FQ7
12AY7/6072	plus many more
12BH7/6913	

Solid State Circuit Mods

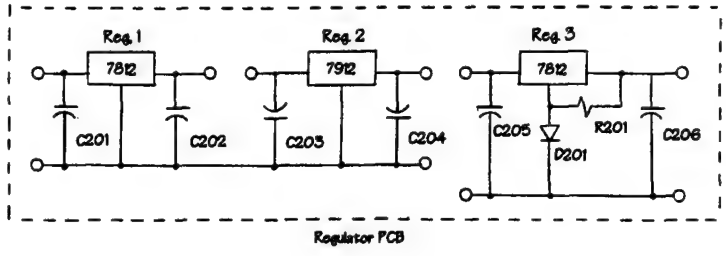
Warning: These mods should not be attempted by the marginally competent because putting a finger too close to the pins of the static-sensitive DAC will very often blow it up, a surefire way to void the warranty. How do I know that DACs are vulnerable? I've fried a couple myself.

The DITB has separate +/- 5 Volt rails for the respective all-digital and D/A sections, a strength in the design. The stock "wall wart" DC supply was replaced by a beefier transformer, soft-recovery diodes, bigger filter caps, and preregulators. This allows the DAC +/- 5V rails to be increased to +/- 8V, which in turn increases headroom.

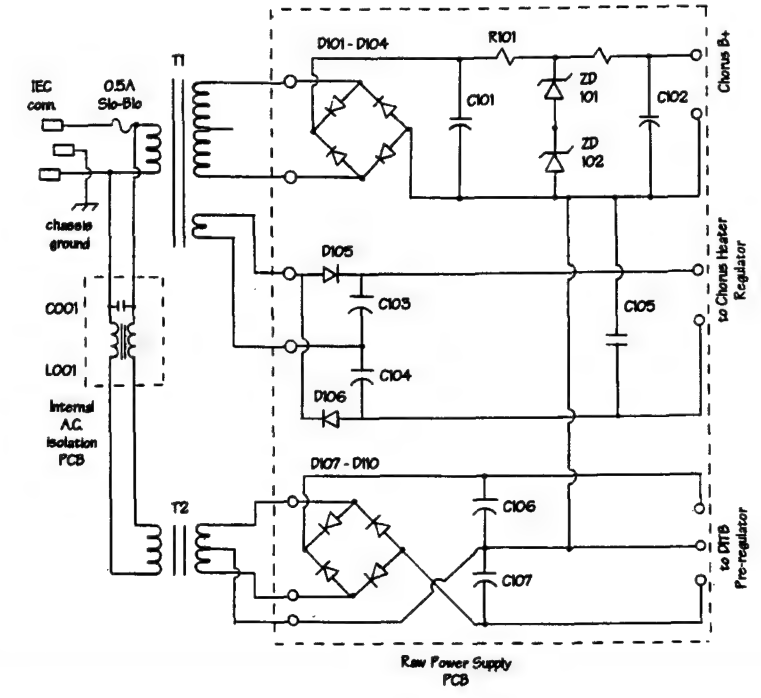


C202, 204, 206 1,000uF/16V Panasonic SU
C301, 303 0.1uF/400V Wima FKP-1
C302, 304 150uF/400V Sprague 81D
Cout L, R 30uF/400V PP Solen
D201 1N4001

R306, 314 39.2K RN60C Dale
R307, 308, 315, 316 47K 1W MO
R401, 402 1M RN60C Dale
C201, 203, 205 100uF/25V Rubycon TWSS



R201 10K 1/2W MF
R301, 309 1.8K 1W MO
R302, 303, 310, 311 182Ω RN60C Dale
R304, 312 1.37K RN60C Dale
R305, 313 1M RN60C Dale



D101-110 SRP 100K General Instrument
ZD101 1N5375A
ZD102 1N5388A
C101 68uF/450V Nichicon CE
C102 220uF/400V Panasonic TSHA
C103-104 3300uF/16V Panasonic SU
C105 0.1uF/250VAC Allied CF-MH
C106-107 4700uF/25V Mallory SKR
C001 0.1uF/250VAC Allied CF-MH
L001 3.3mH/2A Tamura CMF-8033
T1 250VCT/6.3 Allied 6K1VF
T2 25.2 VCT Radio Shack

These mods help remove much of the roughness and veiling present in the sound of the stock DITB, not to mention improving the bass. Removing the output IC (second order filter/buffer) and replacing it with a single pole passive filter/tube output stage removes what is left of the digital/solid state characteristic of the sound, and completes the modification.

Directions for modifying the DITB for use with the Chorus output stage

Caution #1: If these directions don't make sense, let someone else do it.

Caution #2: If YOU do this, you will void the warranty. If Don at Wavetrace does it, the warranty stays in effect.

1. Wear a GROUNDED anti-static wrist strap!!! Use only grounded tip soldering irons/stations!

2. Remove the PCB, holding it only by the edges. Hold the back of the Toslink connector to provide strain relief while unscrewing the machine screw holding the backplate on to it. Set the backplate aside.

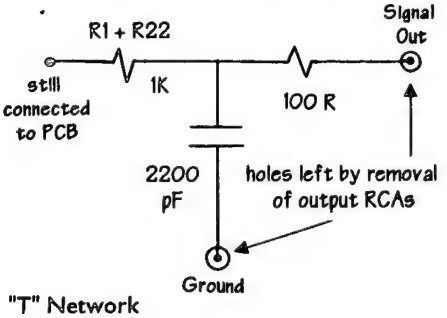
3. Desolder and remove the RCAs and the power connector.

4. Remove the OP-275 output IC. Cut its pins off right at the body of the IC; leave the pins sticking out of the PCB. Don't let the pins touch each other or anything else.

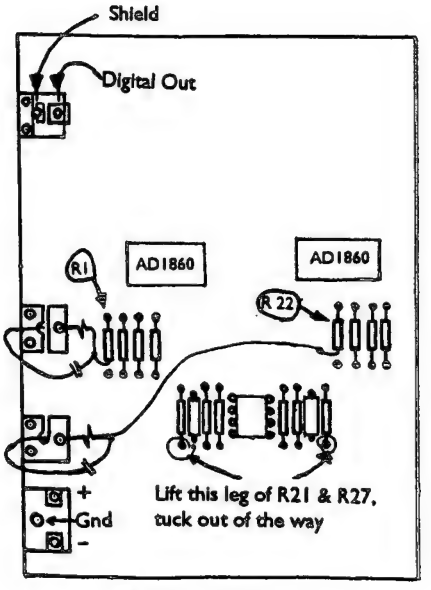
5. Isolate the audio output PCB pads because they are used to anchor the output wiring. Lifting one side of resistors R21 and R37 will do the trick (see diagram).

6. Install "T" network components and new output wiring into PCB holes left when output RCAs were removed (see diagram).

7. Lift the legs of resistors R1 and R22 that are farthest away from the AD1860s. Connect to rest of "T" network (see diagram). The right channel 1K resistor should be connected to its respective 100 ohm resistor with a length of bus wire with the same



"T" Network



PC Board Diagram

diameter as a resistor lead. Insulate the bus wire with something (tape, tubing, etc.).

8. Install RG-187 75 ohm coax into PCB holes left from removing the RCA connector (see diagram).

9. Install power supply wiring. To use large diameter wires that won't fit into the holes vacated by the old connectors, wrap a leftover resistor lead or piece of bus wire around the end of the wire, solder it, and stick that through the hole.

10. Enlarge backplate holes where necessary to clear wiring. Reattach backplate holding Toslink connector when replacing its machine screw.

11. Reassemble. Remember to hold the PCB only by its edges.

12. Connect wiring. Enjoy.

AEP #2: Power supplies

When engineering texts model electronic circuits such as tube or transistor single stage amplifiers, current sources, etc., they treat power supplies as if they were perfect. Man has yet to create the perfect anything, let alone the perfect power supply. In the design of the Chorus power supply, as in the audio circuitry, the foibles of the components comprising the circuit were taken into account. Thus:

1. There is a minimum of the same value/series/manufacturer of filter capacitors on any one voltage rail. This was done to keep any one sonic signature from predominating.

2. Wide use of a. non-magnetic, low temperature coefficient, metal film resistor (Dale). These units were selected for stability and neutral sound, falling between the snappy sonics of the Holco and the extra warmth of the Vishay.

3. Tube output stage coupling capacitors (in and out) were selected for neutrality and, here again, units of different manufacture were mixed.

4. Circuit board traces are kept to minimum lengths. Component groups are connected by hard wiring. This helps reduce the amount of "edge" in the sound.

Plus, all B+ supplies are regulated at least once. The Chorus' high voltage B+ is shunt regulated, enhancing dynamics. The DITB +/- voltage rails are pre-regulated before entering the chassis.

A low impedance regulated heater supply was found to be only a first step. This is usually the limit of sophistication applied to heater circuits because the role of the heater is generally considered to be, well, . . . simply to "get hot." Evidently, there is more going on with heater supplies than one would think.

On a whim, an experimental transient impedance altering circuit was series connected before the 12V regulator circuit. It made a very noticeable difference in the harmonic balance of the sound of the Chorus. The listening skill necessary to hear the sonic differences is on a par with the ability to hear the sonic differences between tubes. At this point, the components used in the heater supply were upgraded. This made for another improvement in the sound of the Chorus and further underscored the need to treat the heater circuit with respect. (A proprietary production version of the initial compensation network comes with the full kits and completed units offered by Wavetrace Technologies.)

I am not alone in believing that the power cord is a major contributor to the "sound" of a product. The power entering equipment from the wall is not just 60 Hz. One hundred and twenty times a second, a burst of power is passed by the power cord as the rectifiers in the power supply become forward biased. This burst of energy has frequency components that extend throughout the audio spectrum. In order to allow for substitution of power cords, an I.E.C. receptacle is standard on the Chorus chassis.

AEP #3: Resonance Structure

This section is about microphonics (vibration induced, narrow frequency band signal colorations) and how to creatively take advantage of them. This will not necessarily be an easy road because the whole issue is so contentious these days. There are far too many who would rather trumpet the instances when a technique isn't significant rather than discovering where and when it is of value.

Microphonics are not exclusive to tube electronics. All systems are microphonic, only the degree and character varies. Harmonic imbalance can often be traced to a "lumpy" distribution of system resonances. This is analogous to standing wave problems in listening rooms. The best listening rooms have evenly distributed modes of resonances (standing waves).

Over the last few years, magazine articles containing snippets of information about changing the resonant nature (and therefore the sound) of everything from capacitors to op-amps have become more and more commonplace. Resonance control devices are hitting the market in ever increasing numbers. In many instances, these devices are designed to eliminate resonances. Control, not elimination, is the key. Other designers, Michael Green for one, share the concept that wholesale resonance dampening is not necessarily a good thing.

Resonances are physical phenomena that have been exploited acoustically for thousands of years. The VPI brick was one of the first audiophile resonance modification devices. Cones, pucks, dots, bricks, and blocks can be found in a large percentage of modern audiophile systems.

The resonance structure of a piece of electronics is affected by the materials that are used in its construction, and by those materials that are in contact with the device. Changing either the materials it is sitting on, or those that are sitting on it, changes the equipment's sound.

A chance discovery manifests itself in an optional 3" circular hole cut in the Chorus' chassis directly over the DITB chassis. A friend blew my mind, and his, by placing a geologic core sample (a cylindrical piece of rock) on top of the DITB chassis back when I was working on the prototype. The sonic difference was like the difference between an 18" bass drum and a 24" one. This first experience led to weeks of experimenting with all sorts of materials, from blocks of lead, wood, and stone, to small plates of fiberglass, Teflon, aluminum and other metals. Some changes were more pronounced than others but one thing became clear: this was not to be ignored. Many were the days when friends would come over to investigate the pile of materials atop the DITB chassis, and to debate which combinations sounded better.

I call these bits and pieces of different material "Transmutation Blocks" in honor of Audio Alchemy. These T-Blocks can be made from commonly available materials, such as oak, mahogany, poplar, copper, aluminum, ceramic tile, fender washers — whatever fits in the opening. They are a do-it-youself item.

Wood blocks have a dual effect. They will dampen some segments of upper harmonics, but augment other harmonics — usually in the lower to middle midrange. Metal and fiberglass discs augment various treble harmonics, depending on the composition, size, and thickness of the disc. Heavy materials, such as blocks of lead, granite, and marble affect bass harmonics. The higher the mass of the block, the lower the harmonics that will be affected.

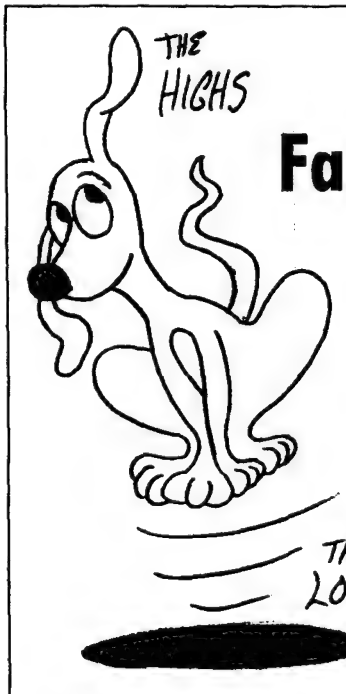
Many people will feel that the Transmutation Blocks are too farfetched. Those wanting to wring that last nuance out of the music will insist on them.

Conclusion

I hope that people will find other uses for the Chorus output buffer. It makes for adaptable equipment that won't be obsoleted when you change other components in your system. When combined with the DITB, it is wonderful (my opinion is, of course, biased). That the heater supply is more important than previously thought should stir up some experimentation and comments. Saying that placing wood blocks and metal discs on top of the DITB can change its sound will make some doubt my sanity and everything else I've ever said. However, all these techniques work towards making better sound.

For more information on the products mentioned in this article, including boards, kits, and complete units contact:

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Largo, FL 34640
813-587-7868 voice/fax



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OHM'S LAW

AN EXPLANATION THAT ASSUMES NO KNOWLEDGE OF ELECTRICITY OR MATHEMATICS

BY "CATHODE RAY"

The apostrophe should be noted, as it distinguishes this law from O.H.M.S. (which deals with *really* unpleasant matters, such as income tax). There is no doubt that many people who are quite enthusiastic about various aspects of radio fight shy of Ohm's Law. It seems to me that there are three reasons—apart from psychological associations with things like schooldays and work—why this is so. One is that references in books usually appear something like this:

Ohm's Law

$$I = \frac{E}{R}$$

$$R = \frac{E}{I}$$

$$E = IR$$

Whereupon the reader exclaims: "I hate (or "I can't be bothered with" or "I don't know anything about") algebra!" And that's that. Another difficulty is that, even when it has been grasped that "I" stands for amps., etc., it is a troublesome sort of business to calculate, for example, the correct resistor to supply 15 volts bias to a valve taking 23 milliamps. The third reason is that amps. and volts and ohms are not things that one can see or understand naturally; they are just so many uncouth words to most people.

Quite Painless

I hope, however, to be able to administer Ohm's Law in such way that the patient (i.e., the entirely non-mathematical reader) has it inside him without any accompanying bad taste having been experienced.

In this present (or Hore-Belisha) era the idea of miles per hour is surely understood by all. What is reckoned in miles per hour? *Speed*. Good! We are getting on! Further interrogation of the kindergarten would reveal that miles measure *distance* and hours *time*. There are thus three quantities—speed, time and distance—and they are related in such a way that if any two of them are known the third can be calculated. Even the reader who prides himself on being one hundred percent non-mathematical would probably have to admit to having, on various occasions, carried out certain of these calculations; nay, more—to having actually done them *mentally*! Thus, if he had just done a journey of 100 miles and had taken four hours over it, he would rightly claim an average speed of 25 miles per hour; calculated by dividing 100 by 4.

What he has done mentally can be summed up for all possible journeys by writing: Speed (miles per hour) is Distance (miles) divided by Time (hours) or, more compactly:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

On another occasion he might be setting out to walk 6 miles; and, knowing that he can walk at 4 miles per hour, he is able to estimate the time it will take by dividing 6 by 4, giving 1½ hours. In other words:

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

In the same way, knowing the average speed and the time taken, the distance covered can be arrived at:

$$\text{Distance} = \text{Speed} \times \text{Time}$$

Most people (even non-mathematical people) probably don't think about having to remember these three formulae. But if they wanted to remember how to do all these three sorts of calculations there would be no need to remember three separate things; all could be done with one:

$$\frac{\text{Distance}}{\text{Speed} \times \text{Time}}$$

Hide the thing you want with your finger, and what is left tells you how to get it.

Anybody who can understand this (and probably most of you feel intellectually insulted by now), and who feel confident in challenging the policeman who alleges infringement of a 30-m.p.h. limit on the ground of covering a measured mile in 2½ minutes, can understand and use Ohm's Law. The one thing to remember is:

$$\frac{\text{Volts}}{\text{Amps.} \times \text{Ohms}}$$

Proceed as directed before (hiding the thing you want, etc.) and if you are given two things you can easily find the third. But before you get busy memorising the above, I suggest that for radio purposes it would be time better spent to memorise it in this form:

$$\frac{\text{Volts}}{\text{Milliamps.} \times \text{Thousands-of-ohms}}$$

Usually one works in milliamps., and it is discouraging to have to convert them to amps., with decimal points and things smelling strongly of mathematics, before being able to use the key. Example: you have a 100-volt HT battery, and you want to know the milliamps. when you connect a 2,000-ohm resistor between the terminals. You hide "Milliamps.," leaving $\frac{\text{Volts}}{\text{Thousands-of-ohms}}$ or 100/2 or 50. Fifty milliamps. is much too much current for an ordinary HT battery, so you now know that it is not a particularly good thing to connect a 2,000-ohm resistor between its terminals.

Having shown (I hope) that calculations by Ohm's Law are no more abstruse or difficult than calculating the average speed of a motor car, I would like to go a little further by bringing to it the aid of visualisation. One reason why it seems easier to calculate speeds and distances is that while doing it one has a mental picture of the vehicle travelling along the road; and it becomes natural to assume that the longer the road the longer the time taken to traverse it. Although it is possible to make electrical calculations with the utmost precision and ease by blindly following the rule just given, it is far more satisfactory and useful to have some mental picture of what is going on.

The Volts Drive the Amps

That lay journalists lack such a picture is evident every time they declare that so many hundred volts "passed through the body of the deceased." The electric current that lights lamps, converts gangsters into corpses, and makes sounds come out of loud speakers, is measured in amps. (short for amperes) or, if in small quantities, in milliamps., which are thousandths of an amp. It corresponds to gallons-per-minute or other convenient measures of the rate of flow of liquids.

Volts are necessary to cause milliamps. to flow, just as a certain amount of pressure or difference in level is required to persuade water to flow through a pipe or along a river bed. The more volts there are, the more milliamps. Nature might have been so arranged that doubling the volts would cause four times the number of milliamps. Or, perhaps, the-square-root-of-two times as many or some other number. It happens that except for special things such as valves (which weren't invented in Herr Ohm's day) it always works out that doubling the volts doubles the milliamps. also. That is what Ohm concisely set down in his Law.

The amount of pressure that is required to cause one amp. or milliamp. to flow is fixed by the nature of the circuit or bit of circuit through which the flow takes place. A long thin pipe laid all round the country would

take quite a lot of pressure to force one gallon a minute through it. So would a very short pipe if it were full of dirt. If we had a unit with which to measure resistance to the flow of water, such as the "resistwater," we might make up an Ohm's Law for water systems: Gallons per minute = $\frac{\text{Pounds per sq. in}}{\text{Resistwaters}}$

Only it wouldn't be true. Electricity is a much simpler, more law-abiding thing than water. That is why, when once people have grasped electrical laws they elucidate difficult problems in mechanics and other things by thinking of them in terms of corresponding electrical quantities. It may sound incredible, but the easiest and best way to find out exactly what will happen to a complicated system of weights and springs and levers is first to translate them all into volts and amps. and ohms. But to get back to ohms—they are, of course, the quantities of resistance to the flow of electricity. Looking at the formula for Ohm's Law one can see that, if the ohms are many and the volts are few, the amps will be very few. That is what one concludes simply by blindly following the Law. But without knowing any Law, if you are told that the resistance to the flow of electric current is great, and the pressure producing the current is small, common sense will tell you that there will not be a very copious current.

Practical Applications

Having got Ohm's Law in easily memorisable form, and some idea of what it means in ordinary everyday language, one may still be unable to make much use of it through failure to recognise occasions when it can be usefully applied. Take the example I mentioned before—calculating the right resistor for providing a valve with bias. It may seem excessively puzzling to talk about a resistor (which is a convenient chunk of ohms), *providing* volts at all, when all that has gone before suggests that ohms kill or neutralise volts, just as a choked pipe opposes water pressure. Exactly. If you wanted to appropriate a small portion of the pressure from a hydraulic main, what would you do?

To make a hole in the main would provide the whole pressure; far too much. But you could take out a section of the big pipe and replace it by a narrower one; this would offer appreciable resistance to the flow and demand a corresponding amount of pressure to overcome it. So between taps situated at each end of the resistance section this pressure would be available. Of course, it would not be available for providing a heavy flow of water; if your private by-pass pipe in which you utilised the pressure did that sort of thing the pressure would drop. In the same way a resistance placed in a circuit for obtaining a desired number of volts will maintain them only so long as it is not abused by connection to a relatively low resistance. The grid of a valve is a practically infinite resistance, taking no current; so this method is very commonly adopted in the so-called "automatic" or "free" grid bias system.

To take a definite example: suppose a resistance connected as in Fig. 1(b) would carry 23 milliamps.; in other words the anode current. And suppose 15 volts are required as grid bias. Then (by Ohm's Law) the resistance is 15 divided by 23, or roughly 0.65 thousands-of-ohms, or 650 ohms.

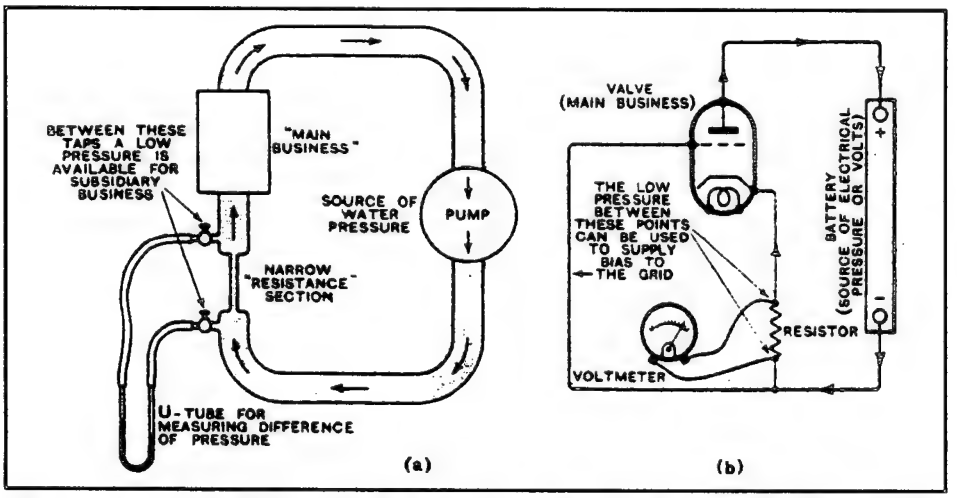


Fig. 1. — (a) Showing how it would be possible to cause a small difference of water pressure between two taps by interposing a narrow pipe in a hydraulic main supplying a high pressure to some machine or other (Main Business). Compare the corresponding electrical system found in most wireless receivers (b).

Another example: you want to find the number of ohms of a resistor. You have a battery and a voltmeter scaled up to 100 volts and marked "1,000 ohms per volt." You first measure the battery voltage accurately and it turns out to be 62. You then interpose the resistor, which cuts down the reading to 18. How many ohms has the resistor?

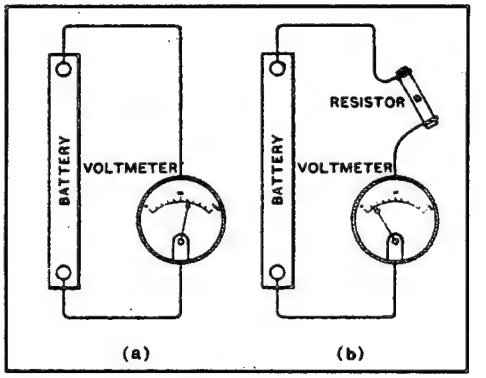


Fig. 2 — A simple method of measuring the ohms in a resistor by means of a battery and voltmeter. Two readings (a) and (b) are taken, and Ohm's Law applied to find the result.

This is solved by the application of Ohm's Law. From the information given we know that the total number of ohms in the voltmeter is 100 × 1,000, or 100,000. In the second test the pressure of 62 volts generated by the battery is applied to overcome the ohms in the voltmeter and also those in the resistor. We know that 18 are accounted for by the voltmeter. So the remaining 44 must be required for pushing the current through the resistor. The long way about it would be to calculate the current by Ohm's Law—$\frac{18}{100}$, or 0.18 milliamp.; then to use this to calculate the ohms in the resistor (because obviously the same current passes through both)—$\frac{44}{0.18}$, or 250 thousand (nearly). But it is possible to take a short cut by noticing that it is not really necessary to find out the actual number of milliamps at all. If 100,000 ohms require 18 volts of pressure to push a current through them, how many ohms will 44 volts pass the same current through? Obviously more, in the proportion of the volts: $100 \times \frac{44}{18}$ = same result as before.

All very useful. But even if one is not concerned with making actual calculations, it is helpful to have an idea of what Ohm's Law means.

From *Wireless World*, Feb. 21, 1936.
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Electronics World + Wireless World



CONEHEAD

La Fevre and Stillwell's article "Desperately Seeking an Efficient Speaker" in *SP* 2:1 struck a chord. Over the past few years, I have been conducting a discreet investigation into why 90% of all commercial loudspeakers have an efficiency rating of around 86 dB/W.

Basically it is down to two things: Thiele and Small and the popularity of 'bookshelf' loudspeaker enclosures. All of the theories associated with these and other 'hand calculator' methods rely on small/medium magnet to cone mass rating, i.e. medium to high Q ratings. Loudspeaker chassis with very strong magnets and light cones, the Lowther PM series being examples - Q about 1, do not work with Thiele and Small.

Thiele and Small rely on the trapped (or trapped and tuned for a ported enclosure) air predictably controlling the movement of the cone. With a large magnet the air cannot load the cone as well, especially when the cone is under 9" in diameter. The magnet is just too bossy. This is a bit of a simplistic statement, but submitting a 30 page epic would be the best way to explain it.

So, for a 5" cone, 84-85dB/W, 10" 90-95 dB/W, 12" 91-96 dB/W, and 15" 93-100 dB/W — all dictated by small enclosures and Thiele and Small parameters.

The strongest loudspeaker magnet I have come across is the Lowther PM4A motor. With its 18 lb. Ticonal G magnet and cobalt pole pieces, this beast packs a gap flux of 24,000 Gauss. Total flux is 385,000 Maxwells. There is only one possible use for such a driver and that is to horn load it.

Quarter-wave loading, large multiple unit systems, and horn loading are the only ways to increase sensitivity beyond the magic 100dB/W mark.

As 90% of all HiFi customers are spending less than £300 on a pair of speakers (in the UK anyway), there ain't no way the majors are gonna bother trying to increase the efficiency. An LS3/5A with a 96 dB/W rating will never happen. You canna change the laws o' physics, Captain.

I foresee a renaissance for quarter-wave loading, a Voigt patent. Castle Acoustics has three models already available and selling like hot cakes, despite a dome tweeter (and a metal one at that). [Note:. The Castle Acoustics speakers are not ultra high efficiency units . All less than 90 dB/W- ed.]

Personal pet hates are crossovers, dome tweeters - especially metal ones, super tweeters, Mr. direct/reflect himself Dr. Bose, computer designed boxes complete with 'bumps' in the bass. Even QUAD electrostatics can now have bumpy bass. Just add a Gradient or a REL subwoofer to raise the subsonics to a level way beyond what it should be. They'll love it at audio shows.

Some people like the phasey ting of a dome tweeter. They love the engineered bump in the bass. It is gonna take a long time for this single speaker quarter-wave loaded pipe dream to become a popular reality.

As Voigt himself once said, it is the midrange where we live, the rest is not as important.

The informed readers of Sound Practices can just relax and be ahead of the crowd.

Haden Boardman
Audio Classics UK

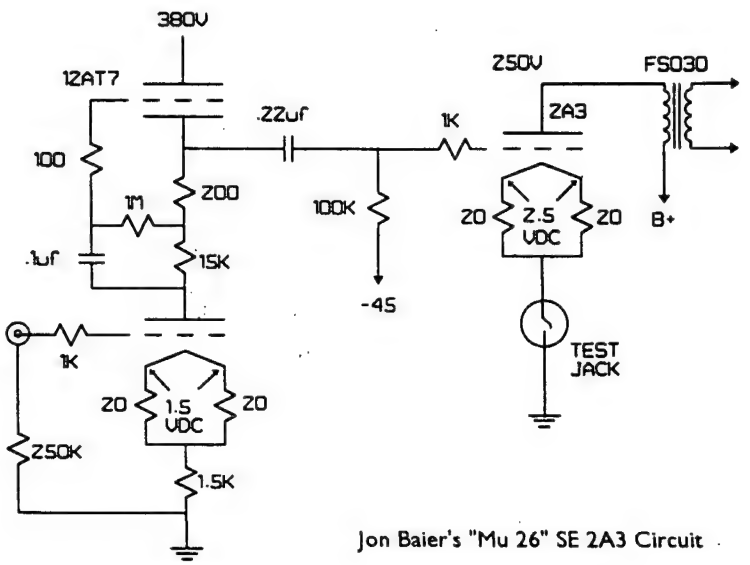
REPORT FROM THE TRENCHES

I got some ideas from the Garrard 301 article. Removed the magnetic brake from my TD 124. Used a small variac to control the speed. The table is quieter. All along I thought I had bearing chatter but it must have been the brake rattling. The problem with the variac trick is that you have to lower voltage so much that the strobe light goes out. I ended up removing the motor pulley and machining it down to 1.032 dia on a lathe. It was 1.075 originally.

The table now runs at proper speed on 117 VAC. I keep the variac in line for minor speed adjustments. One nice thing about the smaller pulley is some increase in torque. The speed seems more constant judging from the strobe. Does it sound better? Who the hell knows? Doesn't sound worse.

I tried just about all the popular output tubes — 300B, 275, 6A3, 45, Chinese, etc. I love the 2A3 double plate. It matches the 604s best. All single plate tubes (of these, I like the single plate 2A3 best) sound lighter and more analytical. The 2A3 bi is GREAT. Others have listened and all prefer 2A3 biplate on my system. Based on my theory that high current, low voltage filaments sound better, I used a #26 for the front end. The amp is much more open and dynamic with the #26 than with any indirectly heated triode I have tried. Also sweeter. It sounds faster than a speeding bullet. Enclosed is a schematic for chuckles. Keep up the good work.

Jon Baier
Schenectady, NY



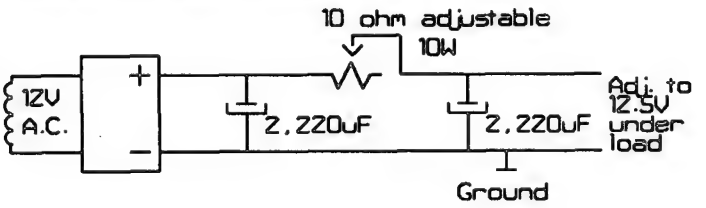
Jon Baier's "Mu 26" SE 2A3 Circuit

Dept. of Corrections — Vol. 2: #1

"Never build anything from a magazine until the next issue comes out."
—Old folk wisdom

Loftin White
Page 6 — R3 should be 3.3K *not* 33K.

REMUS
Page 32 — V3 should be a 12AT7 as indicated in the text, not a 5751 as marked on the schematic. Also, here's an alternative heater circuit that was promised but not delivered:



Incredible as it may seem, V3 may oscillate at a supersonic frequency. Very strange, since it is not a voltage amplifier. A 100 pF cap from V3 grid to ground will cure this oscillation if it occurs.

Hodgson Article
Page 39 — B-H graphs were mistakenly switched in first print run. Corrected in later versions with notation.

The Search for Musical Ecstasy
by Harvey "Gizmo" Rosenberg

RE: TECHNO-SHAMANS
Since the late Paleolithic period, in every culture, a special group of men — those endowed with both courage and gifts — have been responsible for exploring the outer limits of knowledge: ecstasy. We are the modern incarnation of these shamans, and like our ancient brothers we use our music to open the door to higher states of being. Some anthropologists would argue that solder flux is hallucinogenic, the soldering iron is a magic wand, and our single-ended triodes are totems — all used to release a primal instinct for musical ecstasy.

My fellow techno-shamans, now is the time to cast off the mealy minded robe of mediocre audio orthodoxy and explore an expanded gizmological metacontext for the electromechanical arts that create an ecstatic aural metaphor. . . with me.

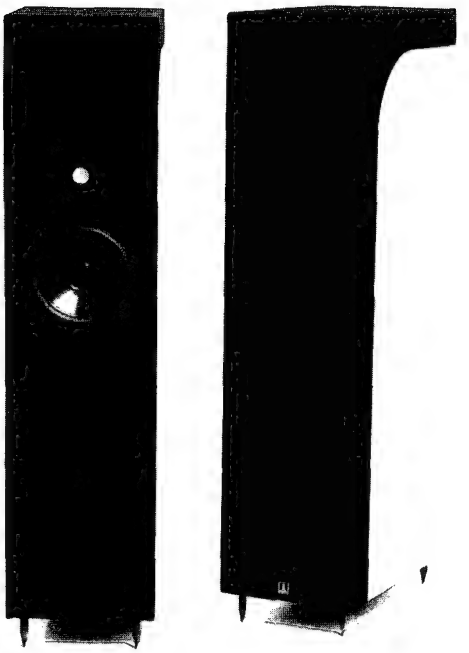


In other words dudes, read my new 350 page richly illustrated book which will stiffen your resolve, conviction, and whatever else you use to explore the audio arts. It is $25, plus $4 shipping, $11 overseas airmail. Send checks, VISA, MC.

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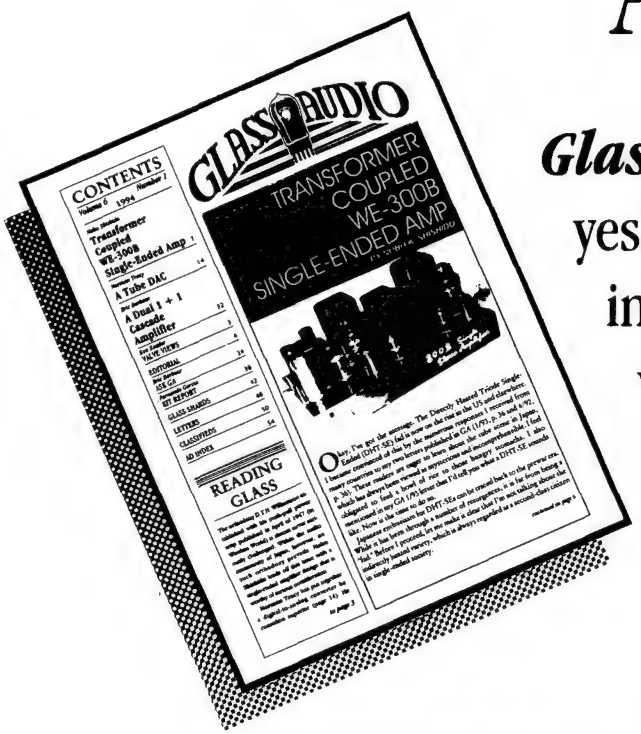
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Since there hasn't been time to paste up, print and mail a "Full" catalog to the many people who have requested one (although I didn't advertise having one!), I've tried to cram as much as possible into this ad. Seriously, folks, while y'all have been out cruising the Internet, having a cold one or soldering your lil' knuckles off, we've been up till way late every night trying to stay caught up with all the orders, enquires, & paperwork. Thanks a million for your business and patience.

My "What I Say Is What You Get" policy means that I *don't* relabel tubes with phony brand names, or put fancy gold lettering and boxes on them, or sandblast them and make up wild stories about where they're from in order to charge you 5 or 10 times what they're worth. I guarantee the goods you get are actually the brand and type advertised. Cheers, Ned The Proprietor.

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12AT7..China Standard 4.95.... .

British 12AT7-white box, "generic" label,may be Mullard or ? 4.95 each

6DJ8 and equivalent (E88CC,E188CC,6922,7308) Russia 6922 5.95...

6550A General Electric USA 6550A-V1 Matched Pair 54.95

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Note:Russian 6550 not compatible with McIntosh and certain C-J units unless bias voltages adjusted. They work fine in most everything else.

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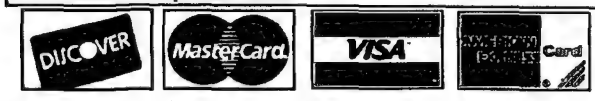
6F8-G these are NOS large bulb 6SN7-G with one of the grid leads exiting out the top cap. 4.95

RK-39, a 1940's vintage beefed up 807 with ceramic base. Raytheon mfr. 24.95 each

Tube Manuals RCA 1959 reprint 10.95 **Western Electric** Reprint 15.95

OEM Spec sheets (usually 4-8 pgs, with curves, etc.) for most tubes available, $2.00 per tube

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All above include our comprehensive manual.



Big NOS Tube Sale!

We just bought a large quantity of mostly US made, new old stock tubes from a local distributor. These are all genuine, no phony relabels. At press time we hadn't been able to finish inventory on this, but we can tell you we have the following types, quantities of each type range from a few dozen to a few hundred of each. Please call for brand(s) and prices.

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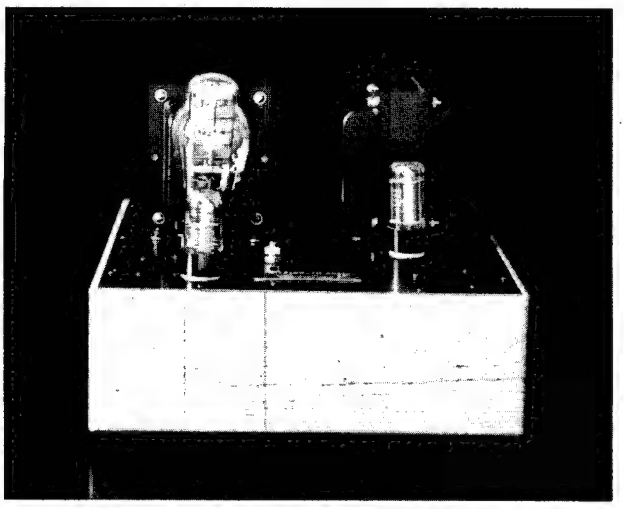
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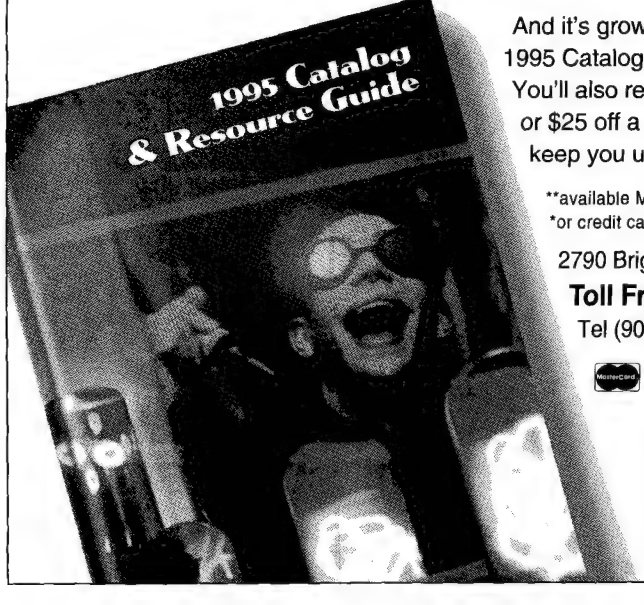
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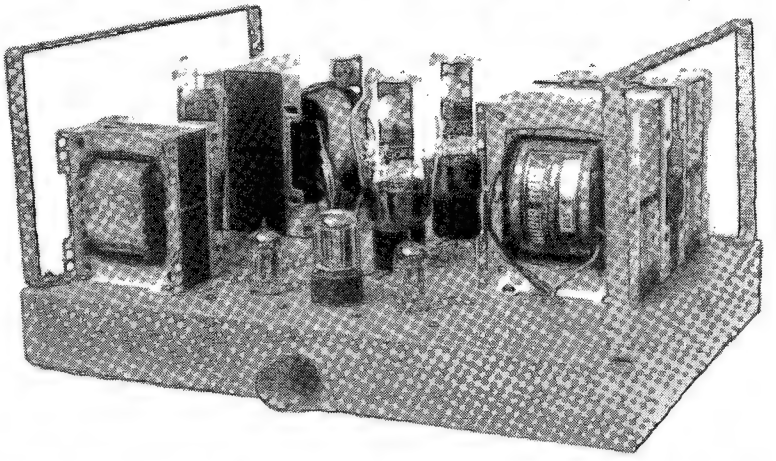
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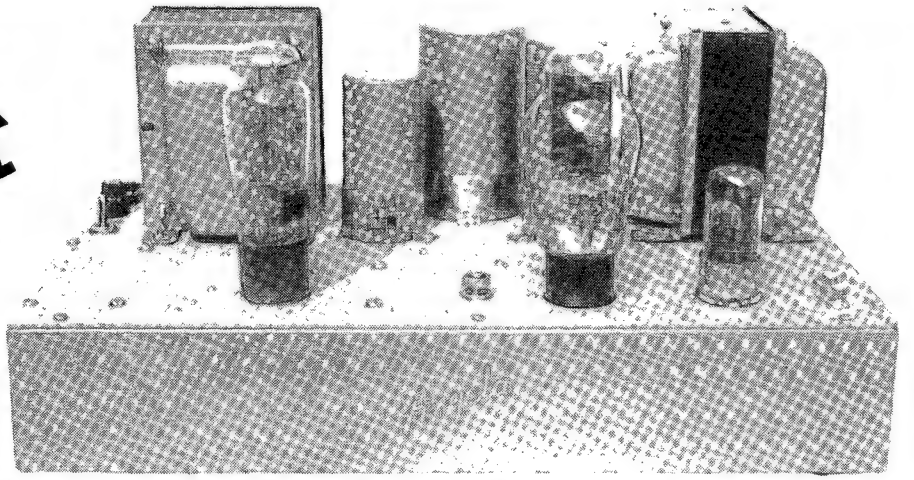
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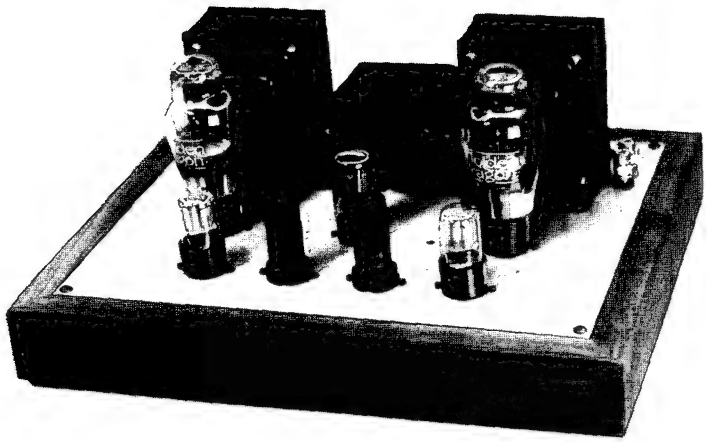
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. . . and MUCH MORE !!!

Fashion is the devil

For a while there, triodes were the biggest craze to hit audio in a decade at least. After years of nothing more exciting than new digital formats, the single ended amplifier exploded onto the local marketplace and captivated the attention of audiophiles and industry gurus. It was different, it was new, it was classic, and it was HIP. At first, triodes had the ultimate qualification for hipness going on — you couldn't buy the stuff even if you had the money. You either had to build 'em yourself or import some exotic electronics from a foreign land.

What followed the revival of triodes did a lot to reaffirm my faith in the capitalist system. As predicted by the classical models, when there is demand some ambitious producer will rise to meet the challenges. Two years later, there are a dozen single ended amps that you can buy, a few real nice triode kits, and a number of exciting new tubes on the market. Everybody is involved in the triode enterprise: the mainstream magazines, the Chinese and Russian governments, and now even AT&T is getting in on the act. There ain't no "In Crowd"— *everybody's in.*

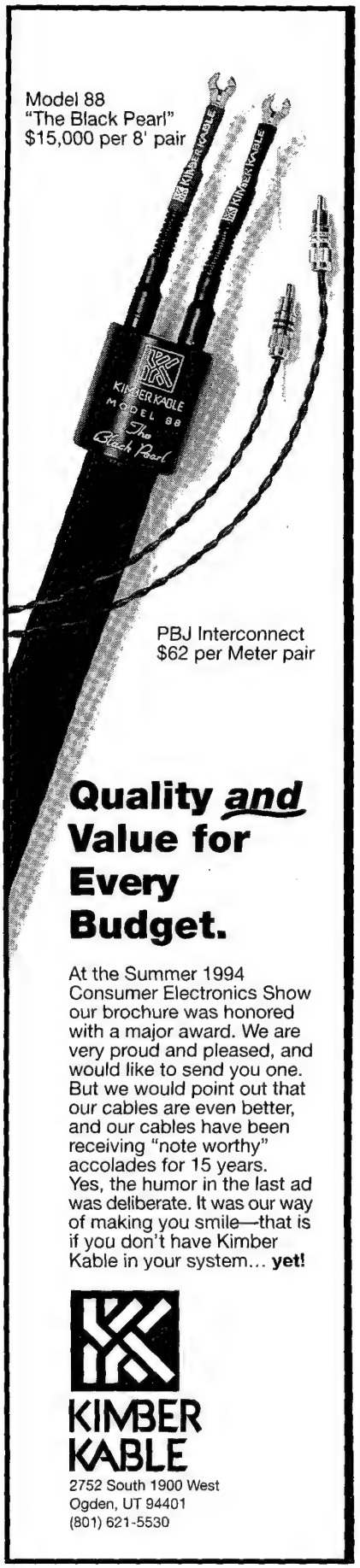
I always welcome heavy capital investment by mega-corporations and foreign ministries of trade destined to enhance my personal music listening pleasure. Let triodes take up the slack in a global economy shifting away from military and defense-related expenditures. If this is New World Order audio, bring it on!

Anyway, the absorption of triodes into the mainstream of international commerce and world audio institutions signals that the era of faddishness for the triode is past and events suggest that some permanence for the technology is guaranteed. Elsewhere on the planet, triodes have been around for a few decades and enjoy a faithful following. For an industry dependent on worldwide export sales for economies of scale and profitability, triodes are an ideal commodity. The language of triodes is today a lingua franca among the top few percent of audiomaniacs everywhere, as it has been for some years in certain pockets of esoteric activity, and I think it is safe to say that we will continue to see an expansion of the triode dialogue and growth in the market for triode-based music systems in coming decades.

Now that the whole issue of fashion is out of the way, maybe we can get down to learning the lessons which this timeless technology offers us. Hopefully, in another few years, we will have a sufficient knowledge and experience base to make good use of this tool. We will need to learn how to build whole systems which showcase the special talents of triode technology and meet its unique challenges. And most importantly, we have to be ready to adapt our ears and our aesthetic systems to measure progress in the new directions in sound that we are pursuing.

One undeniable benefit of the appearance of triode amps on the scene is that it shook up the "high end" where it needed to be shaken, at the level of unquestioned assumptions. For all the self-reflection of the Stateside audio press, they are a complacent bunch as far as the fundamental rectitude of their analytical program is concerned. They act as though they believe there really are absolutes in the experience of musical beauty and they know what they are. Single ended puts us back where we need to be, in an atmosphere of productive mystery, and it reminds us that we are still novices at reproducing music after only 100 years.

As triodes are being taken seriously by more and more people in the business these days, a few traditional industry figures are now calling triodes the "death of the high end." Funny that players in a movement whose philosophical strength derived from a bold willingness to question the supreme importance of specs and put music first are now assaulting SE because the specs are off the map. Triodes aren't the "death of the high end" — rather they provide us with an opportunity to continue in the pioneering spirit of the old high-enders of the 1970s, forcing a radical critique of existing technical and evaluative institutions with the goal of more perfect music reproduction ahead. Tunnel vision or blind adherence to fashion, whether old or new, *is* the death of the high end.

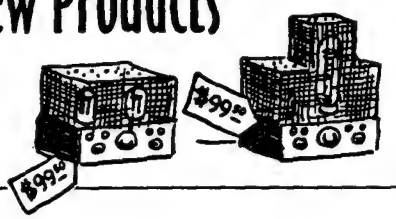


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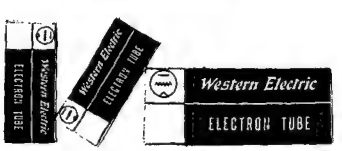
Believe it or not, the famed Western Electric 300B is back in production! That should shake up the 300B market a bit, huh? Pinch me to make sure I'm awake.

The new production WECO 300Bs will be identical to previous production runs, both in performance and appearance. These tubes will be produced in the US from original tooling, materials, engineering specifications, and manufacturing processes. Some of the individuals responsible for previous production are involved in this release. The tubes will be marked with the original Western Electric "flash" logo and will include manufacturing date codes, as did previous runs. Each tube will undergo rigorous quality control testing by AT&T.

Western Electric will also be involved in the digital and analog interconnect market, featuring cables designed under the supervision of internationally renowned AT&T Bell Labs scientists William Nutt and John Plewes. The first Western Electric high fidelity product of the new era, Lightguide ST-II format digital interconnects, will be available very shortly.

The new WE 300B will be available summer 1995. Interested OEMs and distributors may contact Westrex (formerly *Western Electric Export Company, Ltd.*) at the fax number below for more information on Western Electric High Fidelity Products.

Western Electric
Westrex Corporation
AT&T Promenade II
1230 Peachtree Street
Atlanta, GA 30309-3575
404-874-4415 fax



VALVE NEWSLETTER

The Seattle based tube audio club, Vintage Audio Listeners And Valve Enthusiasts, puts out a nice monthly newsletter for vintage tube audio nuts. Recent topics include Heath W5 mods, tube rectifiers, homebrew circuits, and miscellaneous chat about good old tube gear and classic speakers.

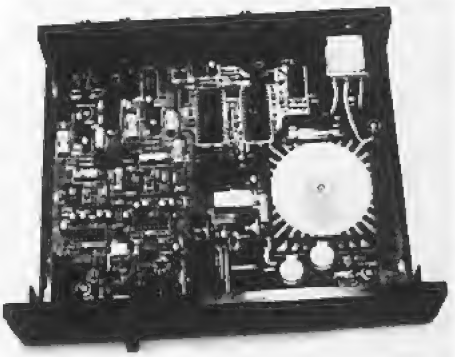
A subscription to the newsletter is $20 yr. US, $35 Overseas. Full members of the club enjoy certain other privileges of interest to the classic hi-fi aficionado. Contact VALVE for more details.

VALVE
1127 N.W. Brite Star Lane
Poulsbo, WA 98370
206-697-1936

DAC KIT

The Parts Connection is offering the Assemblage DAC-1 digital processor kit to the hobbyist market. Designed for the first-time DIYer, it should to go together in an hour or two using only common hand tools and a soldering iron.

The DAC-1 comes with an assembled and tested board featuring a Burr Brown 1702 DAC, a Crystal 1412 input receiver, an NPC 5813 digital filter, Analog Devices AD844 and 847 op amps, and a toroidal power transformer.



Retail cost of the DAC-1 kit is $499 US and it comes with an assembly guarantee in case you can't get it working, a 30 day money back satisfaction guarantee, and a two year limited warranty.

The Parts Connection
A div. of Sonic Frontiers
2790 Brighton Road.
Oakville, Ontario
L6H 5T4 CANADA
905-829-5858



reconsider, baby

The promise of horns in the contemporary situation

by Joe Roberts

For being a totally out of the blue concept, single-ended triode amplifiers enjoyed a relatively easy ride to respectability. The stuff is cool, no doubt about it, and that doesn't hurt a bit. In fact there are lots of people who are big fans of triode amps who never heard them — they got whipped up into a frenzy just thinking about it. Many others who viewed these fleapower amps with suspicion were won over by the *experience* of good triode amps.

Triodes do all the things the mainstream audio institutions say good audio amps have to do extremely well. You want imaging, soundstaging, back wall, yak yak yak? Look no further. The triode is your best friend if 3-D is your illusion of choice. But the lesson in triode amps for the "high-end" is that there are a few things that the general run of audio amplifiers does not do, things that we don't even have words for yet. The way good triodes play music leaves many jaded audiophiles speechless when they hear it.

Then the project of building a system around one of these fabulous amps runs you right into the question "What do I use for speakers?" Good question, one of the eternal questions in audio regardless of whether you're running two watts or two thousand. It gets a bit trickier when you leave behind the established power and sensitivity norms of the industry and enter the domain of "experimentation." With five watts, you're on your own looking for speaks, homes — at least as far as the high end speaker world is concerned.

Believe me, eight watts from a 300B will play many available speakers to at least *medium* listening levels. People are more or less happily running ProAcs, Ensemble Reference 3As, Spica TC-60s, etc. After all, all of these people running around raving about SE amps are listening to them on *something*, no? As reported by CG in *Stereophile*, my two watt 45 amp played loud and proud on a pair of ProAc Studio 100s .

The *subjective* sense of power that a triode amp can deliver far exceeds expectations. It is not unusual to hear reports that this or that >10W amp sounds louder, fuller, and weightier than this or that 100W transistor amp or p-p pentode amp. Whether a particular speaker will work on a particular amp is a question for empirical research. A high and flat impedance and >90 dB sensitivity helps.

From *my* listening chair, I say power ain't nuthin but a number as far as musical and emotional impact are concerned. But my chair is in front of a huge pair of high-efficiency speakers: 15" Altec woofers, Edgar midrange horns, Gauss compression tweeter. The listener with 8 watts and an 88dB speaker will encounter limits. How constraining these limits are depends on your needs. If you really like to crank up your stereo now and again or large scale orchestral music is your passion, the speakers you already have probably won't really shake the rope on three watts.[1]

Triode amps sound great turned up to realistic SPLs, which makes the whole situation even more tragic.

Enter Horns

Thanks to the collective search for good high efficiency loudspeakers to use with low-powered amplifiers there's a lot of curiosity afoot about horn loudspeakers, probably the most unfashionable topic known to the modern high-end. Even 8 track gets more (and better) press than horn speakers in the US specialist mags.

Once upon a time, in the post WWII era, the earliest balls out hi-fi systems were constructed from recycled theater gear. Through the 50s and into the 60s, swanky top-of-the-line home hi-fi speakers featured arrays of horn-loaded squawkers and tweeters. A lot of this plastic horn and phenolic diaphragm stuff is a bit rough on the modern audiophile ear, but it sure was cool to be a "horn man" back then. Ain't that way now.

The need for high sensitivity dwindled as transistor power multiplied. Designers focused on ribbons, electrostats, and miscellaneous cones in sealed boxes intended to be driven by banks of steaming transistors or big hog parallel 6550 amps. The pioneers of the "high-end" as we know it had a different listening program and horns didn't fit. Quite a switch from the McIntosh and JBL 1950's upper crust hi-fi mentality. The horn ceased to exist in the mind of the modern US audiophile, except as a bad joke.

This is where triode amps and horns differ: single-ended amps are something totally new in the Western audiophile cosmos, horns have been tried and rejected. Nothing does more damage to music than a bad horn system and everybody knows it.

You can get a lot of music out of a good triode amp and a *good* horn. But, of course, it's not that easy. One minor problem is that *good* horns are extremely uncommon. Most horns are *totally unlistenable* in a serious music listening context. In my opinion, the bad reputation horns have endured among latter-day audiophiles is largely deserved. Most horns are junk.

But it is obvious that the kind of sensitivity a horn can provide would sure come in handy when you've got three watts and some change to burn. Plus the kind of crazy romantic audio nuts adventurous enough try

1— One obvious solution to the power challenge is to BI-AMP, preferably with crossovers before the amps. Use that SE triode amp on the mids and/or highs and use your Jadis, ARC, VAC, Aragon, or whatever on the low end. I resisted the concept of multiamp systems for years because I thought it was too complicated to work. I was dead wrong. Using different kinds of amps in roles where they'll perform best makes sense to me and it gets around the low power issue entirely.

a single-ended amplifier just to see what it can do are just the type who would gamble on horns too. So, here we are giving triodes and horns, the cutting edge technology of the thirties, a try in the Pentium age.

RISK OF TRIVIALIZING THE ISSUE

Because most horns are awful beyond description, if the goal is to pick up a few tricks which will lead us toward more perfect reproduction systems, we must be very selective. Most horns will be a total waste of time. If it looks like a cheap piece of junk, it is. Any horn made out of thin cheap plastic or cast metal that rings like a bell is going to be a problem. After all, how many cheap thin plastic or cast aluminum musical instruments can you name?

Our forebears figured out that most of those bottom of the line Jensen and EV $6.98 horn tweets were junk back in the fifties. We don't need to go through that discovery procedure again. Because horns vary so wildly in quality and performance, there is a real risk in thinking a "horn is a horn" and leaving it at that. While an "average" triode amp still sounds pretty decent, an "average" horn will DESTROY MUSIC.

Only the top 10% of the horn population is worthy of consideration for serious music listening. A few lesser horns are okay to play with for fun and may do some really interesting things, but they will have at least one dire failing which will have them in the garage after a few weeks playing time. Leave the junk in the airport paging systems where it belongs.

In recent attempts at covering the "Horn and Triode Scene," whatever that is, one big reviewer hooked up some cheap and junky squawk boxes with popularly priced SE amps and, in essence, reported that "Wow, this is better than I thought it would be but it's not that great, *really*." The writer was obviously having a good time, which is fine by me, but I don't think that he exhausted the possibilities of the horn genre with that experiment.

Screwing around with some funky cheap speakers is great recreation — I do it every chance I get— but it will not provide a lasting contribution to the goal of achieving real magic in the listening room.

What is needed is a *profoundly deviant* mindset. We have to search for something *way better* than what we've got to get where we need to be. Our sights must be elevated. Listening to junk and finding that it is slightly better than expected does little to shake the pillars of mundane audio practice.

If we start dredging up all the trash horns that have been justifiably scorned for years and reverifying what we already know, i.e. cheap horns flat-out suck, we run the risk of trivializing the issue. A serious dialogue on horns, centering on open-minded evaluation of the finest of the species and reevaluation of our present-day goals and achievements, might get us to new and exciting places.

Horns and Mainstream Aesthetics

One day I was discussing the marketplace realities of horns with Peter Qvortrup of Audio Note UK. He evaluated the situation thusly: "There is so much suspicion about horns in the marketplace that listeners will be against the product before they even hear it. If you go out on the market with a product that doesn't do what they want and *expect*, you'll get destroyed".

Come to think of it, there *is* a bit of a party line regarding what constitutes "good" in the audio mainstream, a standardized aesthetic program. So what if horns do some musically relevant things better than cone and planar "high-end" speakers? Even the very best horns I have heard do not do some things on the 1994 Official Audiophile Speaker Criteria List.

Peter's findings were that horns do not give you "hall sound" and he predicts that reviewers will freak out if there is no "hall sound" regardless of how right the speaker is otherwise. Minus this critical performance factor, there could be PR problems ahead for our old friend the horn speaker.

I personally think "hall sound" is a cool illusion. Hall sound, as I understand it, is a recreation of the original acoustic space in which a recorded performance took place. This is, of course, partly a matter of the quality of a stereo recording, but a reproduction system has to be tuned in the right way to furnish an illusion of the original recording space. It's become a given that good systems do all this "hall sound" stuff right and a lot of contemporary audiophiles like this phenomenon. Most, I am sure, never questioned the issue since it sounds so good on paper.

Granted that hall sound is a neat illusion, isn't it strange that when we are supposedly trying to get to the sound of live music, we evaluate what we hear in terms of "soundstaging" and "imaging"? These concepts are strictly audio geek notions, totally irrelevant to the experience of live music. The language some people use to talk about reproduced sound suggests they are more concerned with questions of architectural acoustics of the hall than the music on the stage.

Trivializing the issue . . .



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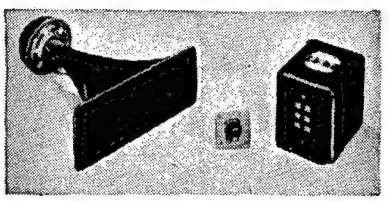
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2-way speaker with 15" woofer



2 x 6" horn tweeter

75W rms, 150W max. 2 kHz-25 kHz. 94 dB SPL. **40-1379 14.99**



KTX-3 STEP-UP KIT

Provides efficient, distortion free reproduction from compression-driver horn-loaded in the important midrange from 600-4000 cycles. Converts Jensen "CX" Series and similar speakers to a true 3-way system.

Dionomite!

At $25,000, Be Yamamura's full-range, single driver, multi-horn *Dionisio* is unlikely to show up at your local high end saloon, or in my system, for that matter. But after listening to a cone-driven Edgar mid horn for a few years, I am a champion of this concept. At a range of ten feet, metal midrange drivers can blast a hole in the wall behind your listening position. A horn loaded cone can really sing close in.

The *Dionisio* uses a modified Lowther PM-4 to drive this 2.3 m tall cork covered fiberglass sculpture between 27 Hz to 16kHz with better than 100dB efficiency. Said to play on two watts.

Yamamura has various smaller and larger versions of the *Dionisio* in the works, some priced down in the economy car range. Crazy price aside, paper cones, cork, and no crossovers sounds like a reasonable recipe to me.

US Representative:
Virtual Audio
POB 1598
Novato, CA 94948
415-898-8067



Dionisio

Once Heard, Never Forgotten —

so goes the motto for the Turbosound line of top-shelf pro sound speakers.

Next time you want to hear Dark Side of the Moon, wheel in a pair of Turbosound monitors and put the LS3/5As in the closet. If they're good enough for Pink Floyd concert performances, maybe they're good enough for our home systems.



Turbosound TCS-612

The TCS-612 system pictured above is set up for bi-amping with an electronic crossover. LF sensitivity is 98 dB @ 1m/1W and HF sensitivity is 103 dB @ 1m/1W. Response +/- 4dB 60-20000 Hz.Nice comfortable 16 ohm load. Size is manageable: approx. 23H X 14.5 W X 14.75D. Midrange uses a horn loaded 6.5" paper cone with concentrically mounted titanium compression driver tweeter. The 12" bass is reflex loaded. Turbosound also makes some mighty impressive high power systems with modular components in the 106-108 dB sensitivity range.

I haven't talked with anybody who evaluated this stuff with triode amps in a home listenihg situation but it sure looks promising in theory. Can audio nirvana be found in the pages of *Mix* magazine?

While it is nice to sit in a great hall and hear some unamplified acoustic music, it is unnatural to focus on the hall sound while you are there. You came to hear the music, right? Nobody talks about music that way and, as far as I can tell, live music doesn't even do most of the 3-D stuff that audiophiles insist on from their systems.

Furthermore, the effect of imaging is contrived and fake even when done well. I loved my Spica TC-50s but there wasn't any way they could reproduce any music except solo mandolin with a realistic sense of scale. Would you accept what passes for good hall sound in your speakers as good sound in an actual hall? No way, Jose.

Far from being an *absolute* part of listening to music, all this a soundstage jazz is an acquired taste and a rather obscure one at that. I like it quite a bit myself, but it took me a lot of magazine reading back in the Seventies and Eighties to even figure out what the writers were talking about.
Concepts like "dial in the soundstage with some Shun Mook ebony root pods from Mother Africa" are not intuitive. Ever notice how your non-audiophile friends never volunteer that your imaging is superb or remark, "Wow, I never heard the back wall on that recording before."

If you have to *learn how to hear* this stuff and *learn* that it is important, this suggests to me that hi-fi is not directly realistic despite the claims of the orthodox ideology. What we consider "real" is a matter of agreement rather than anything "absolute". There are codes and styles in reproduced sound just as there are in "realistic" visual art.

They are HERE

Contrary to popular folklore, horns *can* project three dimensional images. They are still "better" images than you get live. Big weighty images that grab you with presence and impact, just like real music, rather than relying on unnatural levels of hot top end "detail" . 3-D is no problem for good horns.

Horns have a very forward presentation. Back in the Seventies, "too forward" was a common criticism of speakers. What people were looking for was that backward sound, I guess.

The illusion horns provide is a "they are here" sound rather than the old "you are there" illusion. That is, the sound is so dynamic and alive that it sounds like the music is going on IN YOUR ROOM. True, the "soundstage" illusion of reproducing the original hall sound is skipped over as a consequence. After a few years of listening to horns, I strongly prefer the "right here in the room" sound of horns to the "looking into the room from a hole in the wall" sound I used to get with mini-monitors.

My real complaint about most soundstage projecting speakers, and I haven't heard them all, is that they can't rock out. Sometimes I just gotta listen to some old Funkadelic and whatnot. Stage boundaries are irrelevant in this context.

Maybe there is some grand cosmic tradeoff between dynamics and soundstaging. I think a lot of the hall sound master speakers

STAGE ACCOMPANY SA 8535 COMPACT DRIVER



Nominal Impedance	12 ohms flat
Frequency range	1-30 kHz
Peak power	1000 W peak /60 W cont.
Sensitivity	125.5 dB @1m/2.83V (127.2 dB @1m/1W)

The Compact Driver is a ribbon driver with a neodymium magnet. Unlike the plumbing fixture pro horns of yore, this unit would be a civilized addition to your listening room decor. The driver only weighs about 9 pounds. The optional wave guide horn is less than 11 inches square.

You might be inclined to think of this ribbon driver in terms of super tweaked up Deccas and Kelly Ribbons. But these hot rods are in a different class entirely. Fitted with the optional horn, they can reach down to 1K, handle 1200W peaks and can produce 125 SPLs continuously. Try THAT with a pair of Decca Londons! I wouldn't stand where you could be hit with shrapnel while attempting it. If you're a *real* headbanger, a cooled version is available that can handle 4000 Watt peaks and crank out 131.5 dB continuous.

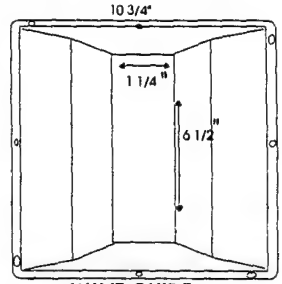
The sensitivity of this driver is so high that the question of compatibility with low powered triode amps and the like is settled in advance. Two watts was enough to blow me out of my listening chair. Funny that they work so well with ancient 45 type tubes when they were designed to withstand the total output of racks of steaming Crown amps.

The 12 ohm resistive load these drivers present to your amps will make your SE triodes smile.

Stage Accompany makes a full line of complete systems incorporating the Compact Driver. Most are 2-way designs with one or two 12" woofers. Not many horn-based loudspeakers can give you such wide bandwidth from a two way setup. Life is complicated enough without a three way horn system in your living room.

At roughly $1300 a pair, the Compact Driver is a bit pricey as an OEM part for high end manufacturers. But if you think you'll find this level of performance for $12.95 from a catalog featuring VCR belts and Pyle Drivers, think again.

US distribution:
Stage Accompany USA
4106 Fox Run Trail 6
Cincinnati, OH 45255
513-528-4035
513-528-4037 fax



WAVE GUIDE

create that unitary soundspace illusion by flattening out the dynamics somewhat and confining the presentation to a small listening window.

How can a 6" cone and a dome tweeter produce a powerful and spatially grandiose recreation of an orchestra? Most of the instruments you are trying to reproduce are way bigger than these dinky boxes. How can you expect "real" sized piano presence or the visceral growl of a bowed cello in front of a 6" plastic cone? Forget it. Getting the dynamics right and a larger sense of scale creates a stronger illusion of reality for me than fake soundstage information, even on well-miked acoustic music.

In Search Of The Perfect Jukebox

Horn lover and audio philosopher Dennis Fraker nailed it down in a recent phone chat: "What audiophiles want is a really good jukebox, except they don't know that's what they want because they never been exposed to it and people are telling them that they want something else. But when they hear it, they know that's what they really want. You know, the right jukebox in the right bar can be magic. . ."

Whew, that phone call went off on a wild tangent, but he had a point there. Back when I was a snobby, sweater-wearing "high-end" salesman I often used the word *jukebox* as a term of derision, as in "the IRS ain't nothin' but a rich man's *jukebox*." Years in the hobby later, I realize that the perfect jukebox is perhaps the loftiest goal a music listener can aspire to attain. And perhaps the most challenging and difficult goal as well. The perfect jukebox, think about it.

If you're looking for buying advice, I can't give you a turnkey horn package purchase recommendation yet. At this stage of my explorations, I have enjoyed glorious results with my enormous 3-way Edgarhorn based system and I found a few "parts" that demonstrate real promise for music listening. The Stage Accompany Compact Driver is one such intriguing "part" (*see sidebar*).

After unpacking a loaner pair of Compact Drivers, I popped them on top of my Altec 416/Onken bass cabs, connected a 10 mF Hovland MusiCap speaker cap in series to roll off the driver around 1 K, stuck a coil in the woofer line, and turned on some music. Nice! LOUD! CLEAN! That was easy. 10 minutes down and we were rocking.

You know how well done live amplified music has that immediate sound that you can't get in your home reproduction even though both are products of amps and speakers? Well, the Stage Accompany sounds like a great sound reinforcement speaker. It's the kind of speaker you hope the jazz club has when you go down to hear Betty Carter and it can bring Betty into your home for your listening pleasure.

Reminds me of a discussion I read on the Internet one time. One sage hobbyist wrote something to the effect that "of course, blues music sounds great on paper cone speakers and tube amps — it was produced on paper cone speakers and tube amps!"

Conversely, if your thing is music that went though a microphone or pickup at the live venue, maybe something like the Compact Driver is what you need. It is musically satisfying and fun to listen to a speaker that can slice through ether the way a Hammond B-3 played through a Leslie cabinet does. Leslies don't "image" and "localize", they energize the whole room.

The ultra clean sound of the Compact driver really helped out acoustic music too. Listening to Ralph Stanley transported me right back to old Virginia. The banjo notes sprayed out like ice and the fiddle breathed and moaned. "Natural" is a good word to use to describe the sound of this ribbon speaker and I'm not using this word in the metaphorical audiophile sense here.

My experiments with the compact driver really showed me some new possibilities in sound. What more could you ask from a component than a glimpse of the beyond? It may be years before you can go out and buy a "high-end" approved horn system. Might never happen. In the meantime, listen and grow.

WHY THIS CULT IS DESTINED FOR MASS SUICIDE



Shopping for speakers for a 7 watt amp with Seth Goldwin

Ya wanna know what's wrong with this magazine? I'll tell ya what's wrong with this magazine, speakers, that's what's wrong with this magazine; that's what's wrong with this whole damned single ended cult trend thing if you ask me.

I got hooked into SE amps by a really great demo of a tiny 3 watt 2A3 amp at the now, sadly, defunct Fi retail store. I then built my own 7 watt AudioNote Kit One amp and have been thrilled by the sounds I'm able to get out of it. But when I started trying to make a stereo system, that is amp AND speakers, based around the AudioNote that I could sit down and listen to day after day I started running into trouble.

I have a pair of NHT SuperZeros that are cheap, tiny, accurate, are an easy load for an amplifier to drive, sound great and even look pretty good. But the maximum cruising volume I can get out of them from my 300B amp is about 90dB. To get more volume, I gotta get more efficient speakers.

To get an equivalent range of frequency response from a cool, modern, miniaturized horn, like those from Dr. Edgar, I would need a four way, Frigidaire sized system. And that *is* the mini version. An even cooler retrochic WE VOT setup would require a Manhattan living room for each speaker. No wonder Vinny "Retro Boy" Gallo decided mono was the key to the future.

So I started looking for speakers that you can actually go to a store and buy, that might fit into a human's house, that cost less than a car and that can be driven to ecstasy by a 7 watt, 300B amplifier. I scoured the *Audio* Equipment Directory. Out of five billion speakers listed there, about a dozen have claimed efficiencies of greater than 95dB.

I have listened to tons of the less than 90dB efficient speakers most people buy, the stuff that clogs up most of the pages of the Oct. *Audio* directory issue. I know how rare a good speaker is *regardless* of how big your amp is. Trying to find the gems is like playing the percentages with women. If you hit on every damn female that ever crosses your path, eventually one might come across. On the other hand, nothing in the laws of nature says that one absolutely *will* come across, but it might make you feel better that you've put in the effort.

A much better method is to get introduced by mutual friends who *might* help to filter out some of the psycho sludge that seems to be my primary date material (not you, sweetie, you're special), not to mention the class of speakers I end up living with.

So I tried to be smart. I asked around a lot to find out what people are using with their 300B amps. Boy, did that get me nowhere. People are using EVERYTHING! Linaeums rewired with silver, new and old QUADs, Radio Shack shitboxes, ProAcs, AudioNote's "I am not a Snell" lookalikes, Klipsch (of *course*), and many, many, many homemade bastardizations of time honored horn systems.

But nobody I know of is 100% thrilled with their rig. Everyone's constantly diddling. Personally, I dig diddling. To a point. Then I want to sit down and listen to MUSIC, know what I mean?

The two speakers I listened to in the last couple of months were not specifically designed for use with watt wimps like the AudioNote. The Klipsches discussed below were designed for megawatt home theater installations. Those down cats in Hope, Arkansas probably haven't seen a functioning tube amp since the 60s. The Swans were designed for wimpy amps, but not quite as wimpy as the ones *I* like, expecting to see something more like 20 to 100 watts. Nonetheless, both speakers fit all my other criteria for availability, size and cost and at least *offer* the possibility of delivering the sonic goods from a tiny SE amp.

KLIPSCH EPIC: HIGH END HORNS!

When I read that Klipsch was introducing a new, audiophile oriented speaker line I got all excited. And every SE cultist I spoke to about it also got excited. Then I flexed the reviewer muscle and got a pair of the Klipsch Epic CF-3s trucked to my apartment. Now I was *really* excited!

The new Epic series is Klipsch's attack on the high end audio/video speaker market. The series are all pretty alike, varying mainly in woofer and cabinet size. They are two-way bass reflex designs, set up in a

D'Appolito fashion with identical woofers receiving an identical signal from the crossover, surrounding a plastic tractrix horn tweeter.

The Epic line starts with 6 1/2" woofs and tops out at 12". The one I got is the CF-3, second from the top, sporting twin 10" woofers and at the bottom, two front facing bass ports. The CF-1's, with the 6-1/2" woofers claim 96dB efficiency. The ones I got claim 100dB! Cool! ROCK 'N' ROLL!

Klipsch designed these speakers for actual living rooms, unlike some of their older designs which seem happier in more, uh, exotic settings like, for instance, someone *else's* living room. While still pretty big for the modern home at 41" X 17" X 17", the review pair came finished in a very nice light oak veneer and actually was a lot less overwhelming in the room than I expected a box of this size to be. The front of the speaker is a black inset with beveled edges to reduce diffraction. Covering this is an easily removable (and replaceable) cloth grill cover. I felt the covers ever so slightly muffled the sound and left them off most of the time.

A lot of technology has gone into these speakers and the designers have spent a lot of time playing off the lobing characteristics of the cone woofers and the horn tweeter to achieve a more tightly focused spray of sound than you usually get out of a horn system, the net result of which is supposed to be imaging and soundstaging, two areas high efficiency horn speakers have traditionally sucked at. Did they succeed? Have I mentioned the 100dB efficiency?

YOU CAN'T ALWAYS GET WHAT YOU WANT

I was warned by Mike Dyer at Klipsch to break these babies in for at least 20 hours before listening to them. I was so excited to get them though I ignored his warning and fired them up the minute I had pried them out of their boxes. BOY, was he right. Completely dreadful, ragged, peaky highs and WAY boomy bass. I resolved to always pay attention when Mike tells me something.

To break the speakers in I pushed them together face to face so they were firing into each other, reversed the phase on *one* of the speakers and threw a blanket over both of them. This arrangement very substantially cut the volume of the sound crud leaking out of the speakers so I could then safely blast track 8 off the XLO test disc on infinite repeat all day while I went off to my job. The XLO break in disc sounds like broadband pink noise with a frequency sweep over it and seemed to work pretty good but I would think that setting your tuner between FM stations would be just as effective. Or playing Maceo Parker's *Life On Planet Groove* over and over until your cats are ready to knife you the minute ya' git home.

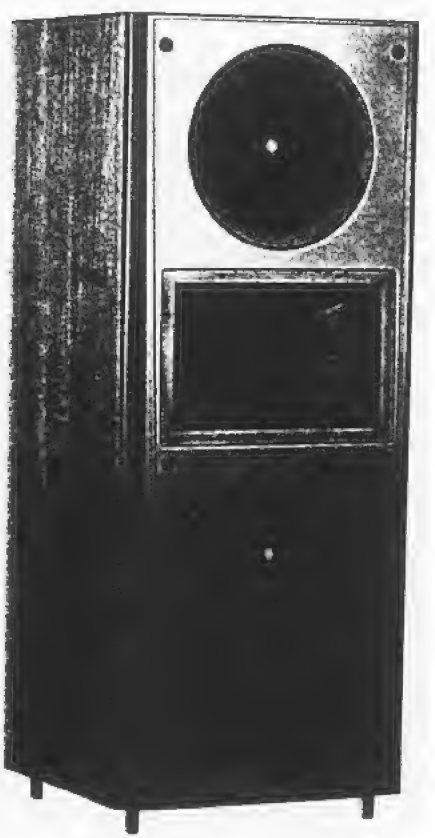
When Mike warned me about the break-in, he also told me to take off the rear set of spikes so the speakers would have that ever-cool pulling-a-wheely look and to make sure that the listening seat was 1.33 times the distance between the speakers. I played around with all sorts of setup options, finally arriving at something sorta like what Mike suggested.

To begin with, I was too close to the speakers and they were too close to each other. Unlike the NHTs, the image these throw is strictly limited to between the speakers. Supposedly because of the Controlled Focus technology, the Klipsches don't seem to mind being close to the sidewalls, a situation that usually results in smeared imaging. At any rate, the imaging never got better as I squished them closer together. In order to get more distance between the speakers while still maintaining the 1.33 to 1 listener/speaker ratio I had to disassemble and redo my whole room. This additional space between me and the speakers paid off and I didn't feel quite as assaulted by these kinda upfront speakers.

Finally, I got them into what I thought was the best sounding position in my room, about 28" from the center of the speaker to each side wall and 65" from the wall behind them, with each speaker toed in so that from the center of my sofa I couldn't see either side of either speaker, only the front. In other words, they were aimed right at me. This put about 9' between the speakers and me 11' from a point midway between them.

How'd they sound, you might ask? On the plus side, the Klipsches will go just about as loud as I could want them to offa' seven

KLIPSCH *epic* CF-3



Bandwidth: 35-20 kHz ± 3 dB

Sensitivity: 100 dB SPL @ 1 Watt/Meter

Nominal Impedance: 8 Ohms

Power Handling: 250 Watts

Enclosure Type: Bass reflex 2-way

Drive Components:
1-2" (5.08 cm) Tractrix horn tweeter
Aluminum diaphragm
2-10" (25.4 cm) woofers

Crossover Frequency: 1500 Hz

Price: $ 2000

Corporate Offices & Customer Service:

Klipsch and Associates
8900 Keystone Crossing
Suite 1220
Indianapolis, IN 46240

Tel. 1-800-KLIPSCH
Fax (317) 581-3199

measly watts and even at lower SPLs they have wads of dynamics, which my acoustic suspension speakers driven by the same low power amp can't touch for all the tea in China plus a free pass to the new speaker strip-joint down the mall. I did not find them to have the honky sound a lot of people accuse horns of having (although I *am* the horny honky a lot of people accuse *me* of being), nor was there any evidence of the uncontrolled cabinet resonances that others have reported hearing from a lot of horns in big plywood bass reflex cabinets.

In short, the CF-3 seemed like a reasonably flat, reasonably accurate reporter of the frequencies and dynamics recorded on the CD. There was a touch too much upper bass energy which gave a full, exciting sound on some cuts, like Nirvana's "Teen Spirit" and Metallica's "Enter Sandman", but made other stuff, like Hamiet Bluiett's alto sax on the World Saxophone Quartet's *Breath of Life* sound mushy where it should have been crisp.

Not despite, but *because* of this excess bass warmth coupled with truly swinging dynamics, I found a lot of material I could really enjoy on the CF-3s. Loud, punchy rock 'n' roll played with the volume UP sounded great. The more people who were over at the time it was being played, the better it sounded. *Exile On Main Street*, early Joe Cocker, Creedence Clearwater Revival, nasty electric blues like the Red Devils *King King* played at 100dB just kicked out the jams.

What appealed about these gritty songs played loud was that the Klipsches gave an approximation of the sound of funky electric blues played live in a small club through a PA system. It had the feel of live electric music. I put on "Commanche" off the *Pulp Fiction* Soundtrack which has got drums and bass recorded into the right channel and gee-tar in the left and not a hell of a lot in between. My friend Ron, who was over at the time, said "It sounds just like my band in high school sounded when we played at this shitty little club in Providence. Guitar over *there*. Bass and drums over *here*. I LIKE IT!"

On the negative side, and this tuned out to be a biggie for me, the Klipsch CF-3s just wouldn't know a soundstage from a hole in the ground. As a gross generalization, I've never particularly taken to the horn systems I've heard because of how they fall down on the job when asked to decode the sound of instruments in a room. In my experience horns can do a fabulous job describing the sound of a particular instrument, but they ain't so hot when it comes to describing the complex sonic event of a group of instruments playing together in a space. Or even not playing together in a non-space, like most of the panpotted, close-miked rock 'n' roll I usually listen to. Despite the recording method, most of these discs still have a definite sense of space even if it's a totally concocted one. In all fairness, the Epic was better than other horns I've heard at creating a stereo image. BUT, it didn't even come close to the cheap and li'l NHT SuperZero's I happily use as my usual speakers while I search for the ultimate.

The Klipsches' image usually spread between the speakers, but it was consistently flat, dimensionless, and the horns did about the worst job of presenting soundstage information of any speaker I've auditioned in my room. While I occasionally had a limited sense of depth behind the musicians, I never felt the soundstage come forward and envelop me. And I *never* felt the speakers just disappear. Both of these are regular experiences with the SuperZeros and with the Swans I talk about later.

On music that depended on volume and dynamics to communicate its message the Klipsches delivered the goods. When the message depended on an interplay of musicians in a space, the Klipsch didn't do the job. But even though rock tends more to the former, lots of rockin' CDs I dig the mostest just don't play good on the Klipsches. For instance, Henry Threadgill's *Too Much Sugar For A Dime*. Ostensibly this is a jazz album, as only a band featuring *two* tuba players could be, but with enough rhythmic drive and dynamic contrast to at least appeal to most rockers, myself included. It should be heaven on the Klipsches, but there's such a dense interplay of musicians that you really need a space decoder like the Swans just to figure out what's going on.

Even on simpler material, like Liz Phair's *Exile In Guyville*, sounds which regularly spread across the room and to the back wall with the SuperZeros got flattened into a two foot thick slab anchored exactly by the front, back and outer edges of the Klipsches.

Call me a fussy, picky pain-in-the-butt, but what I'd really like is both volume and space. When I put on an excerpt from Massanet's "Le Cid" ballet from a Klavier sampler disc, it clearly demonstrated both the pluses and minuses of these speakers. This cut is a dialog between the woodwinds and the brass, with a quiet pooty-flooty section answered by a thunderous response from the whole rest of the orchestra. I've found this to be a great test cut 'cause a) it's fun to listen to, b) the thunderous response bit is a great test of bass power and dynamics, c) the quiet parts are a fine test of imaging capabilities and d) there's a castanet that cuts through the orchestra, clearly from far in the back of a big room. If the speaker you're listening to does NOT represent that, it doesn't do soundstaging. Period. The Klipsch didn't do that. Instead, it was just a clacking sound coming from the right speaker. On the other hand, it just rocked the house when the whole orchestra kicked in.

The clincher for me was one night when I had to work 'til 11:00 PM at my real job and came home tense, tired and none too pleased with the world. As I opened the door to my apartment, the thought flashed through my mind "I wish the NHTs were set up so I could just listen to some music." I guess I just didn't want that nostalgic "go to a club, get shitfaced, and wake up in a puddle of your own vomit" feeling that the Klipsches were so good at delivering.

THE SWANS BATONS

The Swans Baton is a regular old floorstanding box speaker, with a slightly better than normal efficiency of 90dB, that gets talked about as being usable with way low power SE amps. So we called Prince Edward Island in Canada and schmoozed it up with Frank Hale, the speaker's designer, and his extremely well organized wife, Margie, who handles calls from pesky reviewers, and got them to send a pair of them for inclusion in this review.

These are damn nice looking speakers. Mine came in a truly gorgeous rosewood with the finest book matched veneer work I've ever seen on a commercial speaker. They are about 40" tall on spikes, 9" wide and 11" deep. They really look good in a room. Too good looking for my taste, but those with more sense than hifiitis, like your wife, will dig 'em for sure. Beneath the veneer is inch thick MDF, heavily internally braced holding a 7" Focal woofer and a 1" Morel tweeter. In other words, standard 2 ways.

YOU JUST MIGHT FIND,
YOU GET WHAT YOU NEEE-EEE-EEED

Right out of the box, these guys sounded good. Not killer good, not sell-the-kids-I'm-never-coming-back good, but good nonetheless. Civilized, correct and pleasing. Definitely, *not* additive. They threw an exquisitely focused center image and they were absolutely no slouch at projecting soundstage info both front and back. In addition the upper end was nice and sparkly.

Basically the Batons did just great on everything that the Klipsches threw up on. Then I started putting on the things the Klipsches did great on. And the Swans didn't do bad with it either. Could have been more dynamic and definitely could have gone louder. But, these are really nice speakers in the ProAc Response 2 class. Grown up, mature, reasonably priced for the quality of workmanship and materials, terrific little speakers.

Given that they're two-ways, based around a 7" woofer with a lotta cabinet, you wouldn't really expect them to go that low and they don't. While they can pump out something from the Stereophile Test CD 2 even down to 25Hz, it ain't a lot and it ain't very pretty. The worst thing about these speakers was a slightly unpleasant quality to the bass information around the region where it stopped being able to produce the fundamentals. It had a slightly sharp, truncated bass sound on some lower down material such as Jimmy Smith's organ bass pedals on *Organ Grinder Swing*. I was able to effect significant changes in the bass by playing around with the distance from the rear wall. Clearly the best, fullest and most pleasing bass sound was with the speakers much closer to the rear wall, like 24" away, than I usually like my speakers. While the bass was pretty good, this position compromised the Batons' stellar soundstaging ability.

So what's a gal to do? Being the possessor of just enough info to feel dangerous I made up a pair of cheap 1 cap/1 resistor, 1st order high pass filters to drain off any low frequencies under say 80Hz and switched those over to my NHT SW2P subwoofer. This allowed me to pull the speakers back out into the room, giving them room to breathe and develop the sense of performers in a room that I really enjoy. Now, I don't know if you'll find this as helpful as I did, but to me it was a big revelation to find out how totally EASY it is figure out the necessary elements in a cheap n' cheerful high pass filter like this.

I had learned how to make filters like this from Corey Greenberg's review of the SuperZeros in the January 1994 issue of *Stereophile*. In the review there's a cryptic footnote from the editor that supposedly tells you how to derive your own resistor and cap values, but it left out crucial information for the electronics novice, such as myself, like a) how to find out the input impedance of your amp and b) how to calculate the combined resistance of the amp and your chosen resistor.

Well, I got the information, and I got it from Corey who was nice enough to help a recent immigrant from buy-it-at-the-store land. He explained it in a totally clear, highly useful way and I pass the info on to you.

First, find the input impedance of your amp. Turn off the amp, plug an interconnect into it and measure the ohms at the other end with your multimeter (put the black lead on the outside barrel of the RCA plug and the red lead onto the pin). Then figure out the values of the resistor and cap to use by doing the following calculations. Its way easier to do this with a spreadsheet than on paper, because you need to substitute different R and C values to get to the corner frequency you want. The corner frequency, by the way, is the frequency at which the sound will be -3dB and then continue dropping at 6dB an octave after that.

Usually, the process is made easier because you might have some caps lying around and that limits the number of calculations you have to make to get where you want to go.

Lets call the amp's input impedance R1 and the value of the resistor you want to use R2. Then figure out the combined resistance of the amplifier and the resistor with this formula: (R1 * R2) / (R1 + R2).

Since the AN impedance measured out at 475 kOhms and I wanted to use a 33K resistor the calculation (475,000 * 33,000) /

SWANS BATON

Bandwidth: 48-18.5 +/- 3 dB

Sensitivity: 90 dB 1W@1M

Nominal Impedance: 5 ohms

Max Power: 200W

Min Power: 11W

Driver complement:
7" cone
1" soft dome

Price: $2075 oak
Cosmetic and biwire options available at additional cost.

Swans Speaker Systems
RR #1 Mason Rd.
Charlottetown P.E.I.
Canada C1A 7J6

Tel. 902-569-5520
Fax 902-569-5123



(475,000 + 33,000) yielded a result of 30.856 kOhms, which we'll now call R.

Then plug the result into the following formula: 1 / (0.628 * R * C) where C is the capacitance of the capacitor you want to use expressed in Farads, so if the cap says .1uF then the number you use is .00001.

Personally, I have a hard time getting the zeros right, so I just add zeros until the resulting frequency looks right. Since I had some .068uf MIT multi-caps in the house, these were what I used. The calculation 1 / (.628 * 30,856 * .00000068) equaled 75.9, just about the Hz number I wanted to get to. The actual filters themselves are easy to make as pie, if, like me, you do all your baking with a soldering iron. For info, I refer you to Corey's original article.

With the Swans set up in this way, I'd come home from 16 hours on the job, exhaustedly plop down into my sofa, listen for an hour or so to unwind, go to sleep, then do exactly the same thing the next day. So it didn't hit me for a while how much I was actually enjoying these speakers. Without a lot of fanfare they were delivering what I needed them to deliver, the music I like to listen to whatever that might be at any given moment, be it Schubert or Sonny Sharrock. They weren't hopping around the room going Oh, look at me, I'm the best speaker you ever did see, Oh, Oh, please look at me, they just sat there doing the job.

The Batons offer first rate imaging and soundstaging, smooth response, detail and clarity without any specific performance characteristic demanding your attention. But, as my friend Patty said one day, "These aren't good speakers for having company over, 'cause they make you want to pay attention to the music." Sounds like as good a distinction between high-end and mid-fi as I've yet heard.

So why aren't I peeling huge wads of dollars off my bulging roll to run out and buy a pair for myself? Whelll, ish like dish: after all is said and done they just don't go loud enough off of seven watts to either fulfill my stringent review criteria or to make me want to buy them. Its no big deal, its not that they don't do what they were designed to do, its not Frank Hale's fault or anything. They just need another 3 to 5 dBs of efficiency more than the 90dB they deliver.

I called Frank and asked him about this and not surprisingly he wasn't surprised. From my chat with him its clear that he thinks the single-enders are onto something and that something is sitting down with your stereo at the end of a hard day or the beginning of an easy one and just enjoying your music. That's what he had in mind for the Batons, and in my opinion that's more or less what he delivers.

Yeah, I had to play with them and use a subwoofer to get the best possible sound in my living room, but even without the sub they deliver the musical goods except on the most way down material. But, they don't go loud enough and Swans knows about it. Frank is designing two new speakers, which will get their introduction at the Winter CES in Las Vegas, designed to eke a few more dBs out of standard cones. Based on my pleasing, but too quiet, experience with the Batons I'll look forward to hearing them.

THE EVIL TWIN SYNDROME

After having the Batons as my main speakers for about five weeks, I put the Klipsches back up while I finished the review. It's just two different worlds. The Klipsch has got all the volume and dynamics you could want but it literally flattens every disc. The Batons don't play loud enough and don't have half the dynamic swing of the Kippers but paint a really full blown, wall-2-wall 3D sonic picture. It's the evil twin syndrome. If I was forced at gunpoint to choose one of these two speakers, I'd have to pick the Swans because they play more of my music but the Klipsches were definitely a lot of fun on certain material. What I'd really like is to force the Klipsch and Swans to mate so's I could buy the bastard children. Except with my luck, recessive genes from nowhere would land me with a squalling baby Bose AM-5!

AES SE-1 AMP KIT UPDATE

After last issue's love gush on the AudioNote Kit One, I started thinking about the ol' unloved AES SE-1. How could I improve it?

Joe Roberts had some good (and CHEAP) ideas so I tried them[1]. I unsoldered the 10K metal resistors going from pin 3 of the power tube socket to the terminal strip above it, and replaced 'em with 15 cents of Radio Shack 1K carbon resistors. And I removed the poly bypass caps around the big 'lytic cap on the left (when the amp is upside down). I was rewarded with an increase in transient response, but now it was harsh, baby, harsh. I took one of the Vitamin Q caps I had been only too grateful to remove just weeks before and used it as a bypass on the big cap. Now I was getting somewhere! This combo gave me the increased snap I was looking for but without the grating harshness I wasn't looking for.

But still I didn't prefer the SE-1 to any of the other amps I had. I pestered Joe to send me some 2A3 tubes. (*You better lay off my stash, punk—ed.*) He finally dug up a pair of used GE babies that he said tested good. I geared myself up for a major redo of the amps internals to fit this new tube. I sat down to plan my strategy and came up with the following: throw the tubes in and readjust the bias to 100ma. That's it. That's the extent of the mods needed to try the 2A3.

And, man, did it pay off! Finally, a setup on this amp I could actually enjoy. Less power, even lower volume, but smooth, integrated, loads of detail and no obvious weaknesses at either frequency extreme. The amp even looks better, more correctly proportioned, with 2A3s in it.

So why does the SE-1 do so good with 2A3s and not do so good with 300Bs? Could it be that the 337V B+ supplied to the tubes is just about perfect for a 2A3 type tube, but a little skimpy for a 300B which really wants more like the 420V supplied by the AudioNote? But if it's perfect for a 2A3 tube, why is the SE-1 sold as a 300B amp? Beats the hell out of me, that's for sure. I just wish I had some great sounding high efficiency speakers so I could really hear those 3 watts.

MANUFACTURERS' COMMENTS

SWANS

Thank you for the colourful and positive review of the Baton. We are honoured to be in the pages of what I consider a vanguard magazine. Although there are many that still consider single ended amplifiers to be a fad, we look at them with the same interest as the introduction of the CD. They are definitely here to stay. Now if we only had a

1— Some experimenters advise changing both 4.7K resistors in the 6SL7 circuit to 2.2K and bypassig the bias supply with a 47 mF/250 V cap between the bias adj. pot and the 220K grid resistor. Try it.

decent selection of speakers for these babies...

There is hope. While most high-end manufacturers are pursuing the audio-video market, Swans has decided to dedicate all of its R&D efforts to designing speakers that work well on low, as well as high, wattage power amps. All of our new speakers including those at the WCES will be at least 90 dB efficient.

Seth, your analogy between finding the perfect date, or "the Speaker from Heaven," rings a familiar bell. Unfortunately many get led astray by purchasing equipment based on what they have read rather than by what they hear. After a while one learns that life is filled with compromises, no matter HOOOWWW much you spend or look. Anyone who says differently is a liar.

As an audiophile I have constantly been frustrated auditioning two way designs that would be fine if they just had a little more bass. Finding an efficient speaker that does this narrows the field significantly. The Baton is not audio nirvana incarnated, but it does deliver a full and satisfying sound that is not analytical or hard. With the right amp it delivers emotion in aces and spades. In my wife's (and business partner) words when she heard the Baton for the first time, "It's like being wrapped in a warm blanket." In Seth's (if I may anticipate), "But sweetie, it's better with tubes."

Frank Hale
Swans Speaker Systems

KLIPSCH

Mr. Goldwin's review once again reminds me of the importance of individual *point of reference* regarding audio reproduction. All of our opinions and responses to whatever stimuli are cumulative effects of what we have experienced in the past. As we all know, there is no such thing as "the perfect sound reproduction system". Horns sound different than direct radiators, transistors different than tubes and so on and so on. Any system that we as designers and builders or as consumers and listeners put together will be a series of compromises, maximized to match the priorities of the individual. What is right for one person may or may not be the best choice for another. I refer to this as *point of reference.*

When I worked in a hi-fi store, customers often would come in and ask, "Which speaker is the *best?*" My usual response was "Compared to what?" If the individual expounded on the virtues of this or that hi-fi system, than I led them to a product with wonderful "soundstaging and imaging" and ever important ACCURACY. If, on the other hand, they were musicians or heavy concertgoers, I moved in the direction of products that were strong in dynamics, transient response and "feel". Different smokes for different folks.

During the development of the epic series of products at Klipsch, our goal was to bridge the gap between these two camps. Imaging with punch, soundstaging with dynamics. Finesse at 102 dB sensitivity!

Have we achieved Nirvana? Nah. But we are convinced that the Epic products offer the strongest case to date for a product that can hold its own on any subjective or objective criteria.

Mr. Goldwin's wish that he could have multiple systems available at any given time is not unusual. I know I wish I could have a specific system maximized for each piece of music in my collection. I would also like to own a city house, a country house, a ski chalet, a place on the ocean and one in Hope, Arkansas (to cut travel time and stay out of the Holiday Inn, but that's another story. . .) but I can't afford those either. My point is that all systems make compromises and if a mini-monitor that "disappears" is preferred by an individual, that's OK, but it doesn't indicate superiority over a product that sounds *live* (there I go using those subjective terms again).

Klipsch is a company that continues to develop the state of the art in horn type loudspeakers. As the Klipschorn set the standard for horn type loudspeaker design 50 years ago, so does the epic series today. As the Klipschorn has evolved and improved over the years, so will the epic products. Klipsch is a company that is never complacently satisfied with its products. Our chief design engineer, Roy Delgado, will surely continue to look for ways to improve the epic series, which we believe to be the finest imaging horn system produced by Klipsch to date.

Mike Dyer
Klipsch

Factors Determining Tube Life

by Prof. A.V.J. Martin

Reduced service life is often due to high voltages

SOME of the tubes used in modern electronic circuits are exceptionally hard-working components, especially in television receivers. It is a well-known fact that some of them have a relatively short service life, mainly because of the operating conditions (high power, pulse operation, etc.).

However, there are several common factors which influence the average life of all tubes, namely, excessive heater voltage and excessive plate dissipation.

The effect of heater overvoltage is shown in Fig.1A for a 6.3-volt tube. It does not take into account the probability of the heater opening up but only the exhaustion of the oxide film which constitutes the cathode. The life of the tube at the nominal voltage of 6.3 is taken as 100%.

More frequently, the overvoltage fluctuates around an average value. An unstable heater voltage is extremely detrimental to tube life, as seen in Fig. 1B where curve 2 refers to a tube which is alternately normally and excessively heated. For comparision, curve 1 refers to a tube having a constant heater voltage equal to the average value of the irregular voltage of curve 2.

Fig. 1C shows the effect of plate overload which is evidently less detrimental since an overload of 50% reduces tube life by only 25%.

The conclusion is evident. The best way to insure maximum tube life is to operate all tubes well within their design ratings.

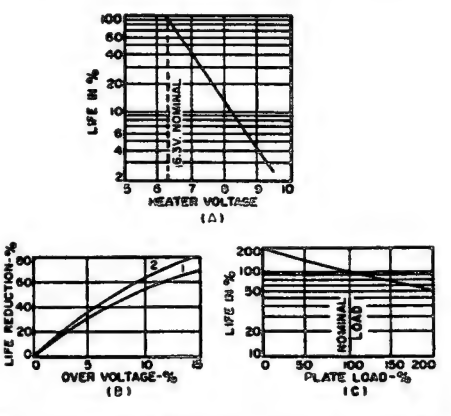
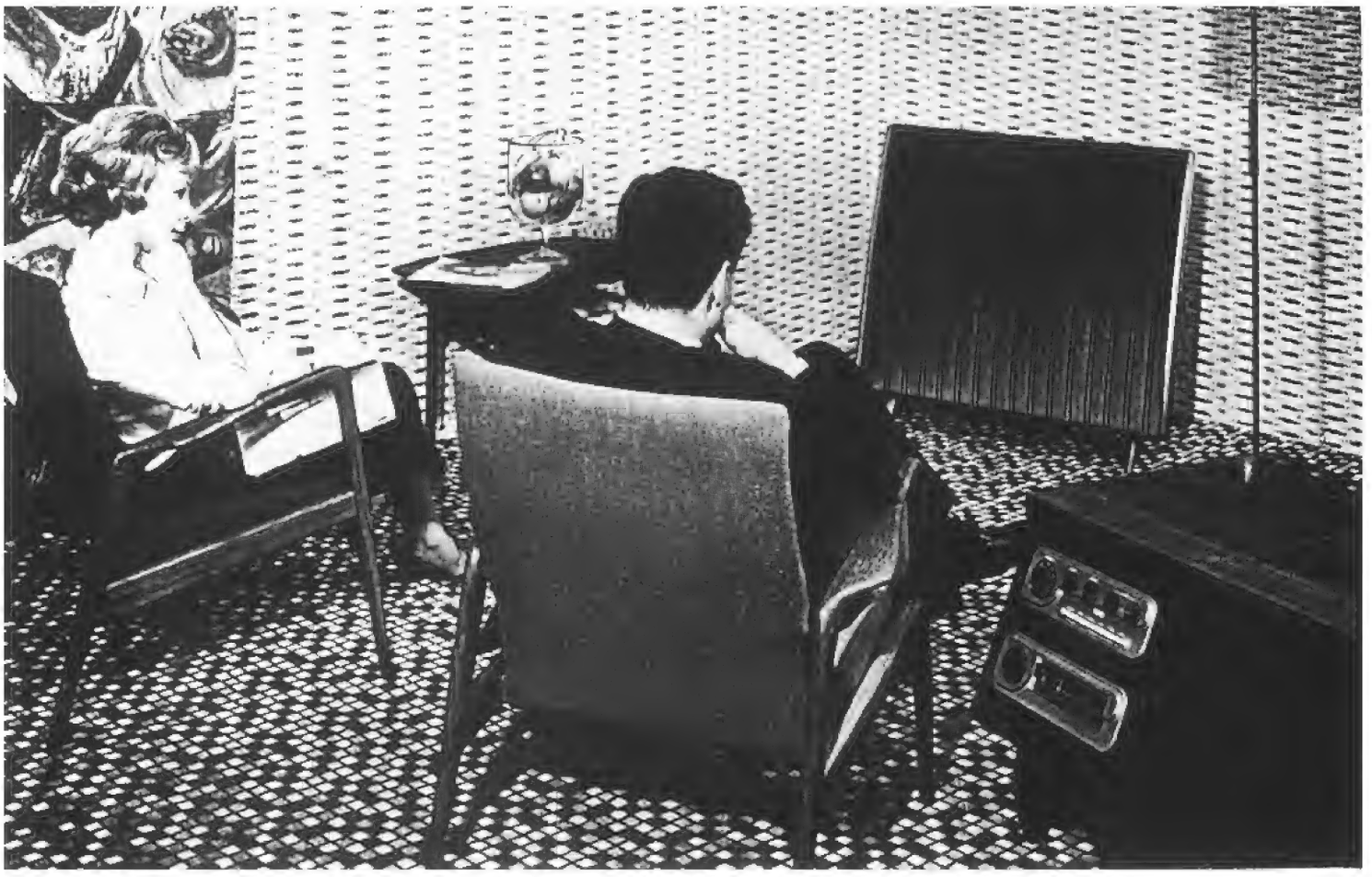


Fig. 1. (A) Effect of high heater voltage on tube life. (B) How fluctuating voltage shortens the life of tube. (C) The effect of plate overload on tube longevity.



THE QUAD ELECTROSTATIC LOUDSPEAKER

by
Haden
Boardman

Mellotone
Acoustics

A good electrostatic has something special, a magic spell that weaves itself over you. Critics (of which there are few) moan on about "won't play rock" or "only for string quartets". Ask these plaintiffs what system they have, or what kind of speakers, and the usual response is some old west coast monster.

Electrostatic speakers generally consist of four main parts: a *power supply*, to provide the necessary electrostatic charge; a *rigid plate* (or plates) to hold the charge; a *flexible plate* to act as diaphragm (only 2.5μm thick in the QUADs) which makes the music, driven by a *step up transformer* to multiply the voltage output from your amplifier to a level high enough to move the flexible plate.

It's a difficult thing. The fixed plate has to let the sound pass through it, and so is usually perforated. The flexible plate has to have near zero mass to be moved by the output from the amplifier. It's amazing the whole thing works at all.

It's funny that while in studios condenser microphones are the bees knees, the electrostatic loudspeaker has never enjoyed a similar level of "professional" attention, and therefore suffered a relative lack of development.

Although electrostatic speakers have been known to exist from the nineteenth century, the first *commercially* made speakers were fitted to a few picture houses in Chicago in the late 1920s. Nothing is known about these early devices, if anyone has any information about these I would be delighted to know.

Peter Walker was the first in 1956 to offer to the public a High Fidelity electrostatic loudspeaker. Others have followed: Acoustats, Audiostatics, Dayton Wrights, Martin Logans, etc. But QUAD were first. QUAD still manufacture an electrostatic, of course. 1980 saw the introduction of the ESL 63, so called because that was the year that Walker & Co. started work on a replacement for the original. In a lot of people's perspectives, mine included, the new design did not quite match the earlier speakers' performance in some areas, for others the new model was a revelation.

The original's cookie '50s look amuses me something rotten. The expanded metal grille, the stubby little feet are all pure 1950's Britain. Most were fitted with "bronze" grilles and with classic teak end caps. Later production had severe (and very boring) black grilles along with rosewood end caps. There were variations — I recently picked up a pair of late 1959 items with black end caps and baby sick green grilles. I will be parading these things about next year at shows, be warned!

There are few, if any loudspeakers that raise as many passions as the QUAD electrostatics. Like the DECCA cartridges, Linn LP12, Tim de Paravicini, LS3/5a and other quirky Brits a relationship with a pair of QUADs is either pure love or pure hate relationship.

Let's get the hate bit out of the way right now. If you head bang, please turn to The Gallo's article (in SP #6) right now, waste no more time, do not pass go, do not collect $200. Maximum SPLs are about 100dB for a pair, in an average British living room, less I would imagine at yer average Texan ranch. Stacking a pair can of course give you far more headroom, if less house room, but more on that later. Subwoofers and other low life can also add a few extra SPLs thanks to the reducing burden on the ESL. But basically ESLs will never make your ears bleed.

The biggest total hate (on my part) is the directivity of the thing. These speakers are *so* directional it hurts. For those inexperienced in the ways of the ESL, these things make a pair of ALTEC 604s sound like an omnidirectional design.

Forget using ESLs if using some super amplifier or super budget amplifier. Powerwise, pair of ESLs need 15 watts per channel, a stacked pair double. Any more and you risk of destructive lightning within your speakers' panels. Due to the varying impedance (1.8 ohm at 20 kHz, to over 60 ohm at 150 Hz.) and highly capacitive load, ESLs are not suitable for any amp that is not totally stable into any load.

I once saw the remains of a little Rotel RA 820BX that some bafoon wired up to a pair of ESLs, the innards resembled a scaled down model of downtown Hiroshima, circa 1946. Craters where transistors once sat, melted resistors and capacitors everywhere. Single ended triodes are fine, in fact more than fine, they're great with the ESL, as long as you do not mind mushy bass.

QUADs <u>have</u> bass, and anyone who wants to argue the toss is either a wimp or tone deaf, so there.

Final fly in the ointment is the build quality. QUAD has a reputation for making the best built kit here in Blighty, and I do not want to chink the armour but it has to be said some of the production techniques used to assemble the originals is a bit dire, if limited by fifties technology. This manifests itself mainly in dust cover rattles. Yes folks, ESLs can rattle, pop, buzz and fart.

Enough of this negative vibe, what about the plus side? Well, thankfully to say it is a much longer list. For spec. freaks, these babies are a dream.

Frequency response? 40 Hz to well past 20 kHz. Distortion? Compared to any moving coil unit, it's non existent. Impulse test? Quicker than the measuring microphone. Fine, but how does this mumbo jumbo manifest itself in the sound quality?

I do not want to mislead subjectives into hating this speaker on the "measure fine, must sound like dog shit" knee jerk reaction — although they *would* be right with some QUAD crap like the 405 family. This speaker was extremely well regarded from the outset. It earned the nickname of "Walker's Wonder" very quickly. Both Harold Leak and Gilbert Briggs went into blind panic on first audition in the '50s. Leak quickly set to work on his own ESL (although nothing other than a couple of *Wireless World* articles ever came of it). Briggs answered with the not totally unsuccessful Wharfdale sand filled baffle three. Logic being if you can do it with static 'lectric you can bloody well do it with big magnet speakers. Even Goodmans (Mr. E. Jordan, one of my heroes) developed one.

A pair of electrostatics can sing. They add no spice to the sound. They play it as the electrical signal on their input terminals tell them. They add nothing and take very little away. The truth, the whole truth and nothing but the truth. If your system is bogus, on the end of a pair of ESLs it will sound "line me up and shoot me" bad. If your system really sings, and does not need speaker coloration to give it bass, check out a pair or, even better, a *stacked* pair.

The most common criticism against them is the lack of bass. This is total bullshit. Yes, the bass will not play loud enough to annoy the neighbours. Yes, it's free from the usual boxy boom most makers engineer into their crappy little box speakers. What bass there is, is clean fast and unbelievably cool. I get totally pissed off with all these "boom" box subwoofers. Most of them have resonances about 30 Hz, adds a Technicolor bass bloom. Christ, even QUAD themselves are at it now. When is a dipole subwoofer not a dipole subwoofer, when its a Gradient of course! As for these over amplified boom boxed which seem to have gathered street cred in the last couple of years, most of 'em are ripoffs of Audio Pro. QUADs have bass, and anyone who wants to argue the toss is either a wimp or tone deaf, so there.



Internal workings of QUAD ESL

At the other frequency extreme it's just as delightful. So clean and free of sibilance. No spit. No sizzle. Nothing added, very little taken away. Some do complain the ESL rolls the top off, and I suppose it does a bit, but then so do half of the single ended amps on the market at the moment. The bit in-between also rates as "jolly". The midrange is ever so natural and unrushed. You could never accuse the ESL of forcing the sound onto you. You walk "into it" rather than it walking over you. I can think of no other speaker that handles the midrange as well as the original ESL, *period.*

By now, you either want a pair or have already turned over to a different article. Two very important words to remember when chasing QUADs: *caveat emptor* or if you skipped on Latin lessons at school, let the buyer beware. And boy, does the buyer have a lot to watch.

Budget on at least £500 minimum for a pair when refurbished, if it costs you any less, you have been very lucky. If buying condition unknown, never pay more than £100 for a pair. Serious. In time everything can and will go wrong with an Electrostatic speaker. Budget on a complete set of new panels, (there are three in each speaker, two bass and a treble panel) plus a new EHT unit. These items cover 99% of Electrostatic ailments.

The treble panel is usually the first to have problems. Solid state amps tend to clip quite hard into an electrostatic speaker (due to the difficult load and falling impedance at higher frequencies). This tends to cause arcing, which burns holes right through the centre diaphragm and removes the electro-conductive paint off the fixed plates. This reduces the efficiency and power handling as well as causing strange popping noises from the panel. Bass panels suffer similar problems, over excursion causing a similar effect, although the symptoms can be more tricky to spot, it usually manifests as lower efficiency.

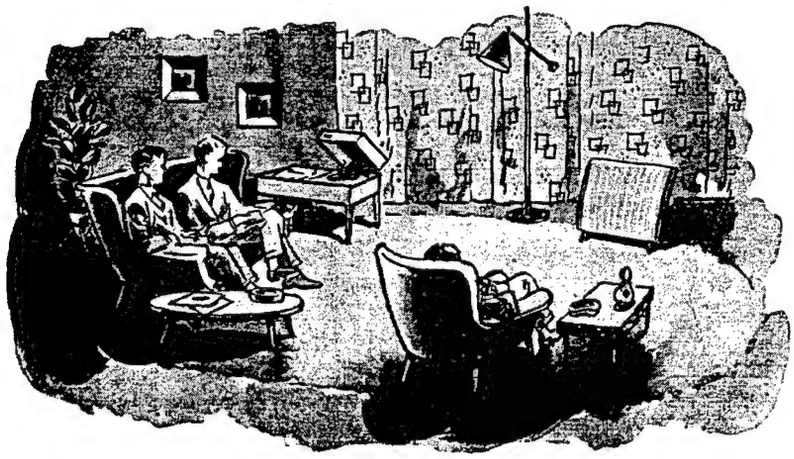
EHT units tend to die with age. Either no output or so low you cannot hear it are the fault. The rest of the electronics are pretty reliable. I have seen both audio transformers and mains transformers dead, and they are most certainly not cheap to source. QUAD automatically fit a protection circuit ("clamp") on the ESL these days, which does its best against abuse. It's not 100% perfect, so watch yourselves.

Anyone thinking about doing DIY work on QUAD ESLs should plan to be extremely careful. Disconnect the mains, leave for a minimum of six hours and disconnect the amplifier. This last bit is very important. The audio transformer steps up the AC signal (sound) to a very high level, if by accident music is playing into an unenergized QUAD and you happen to touch the wrong wire, YOU ARE DEAD. It's far more potent than the ESLs' power supply, due to the low source impedance of the audio transformer.

An engineer for whom I once had very little respect told me in the case of most home brew audio gear said Destroy It Yourself would be more appropriate. Well, an ESL bites back, Destroy Yourself, if you are not sensible, please be careful. Take no chances, electricity takes no prisoners.

Servicing the ESLs is fairly easy. Unscrew the back panel, the wooden end cheeks. Carefully tease out the staples from the metal grill and remove them. If you have no cats, dogs, or rug rats, and don't object to staring at naked QUADs, use 'em like this. The expanded metal grille does a big fat zero for the sound quality, if everything for the looks.

Carefully unsolder the connections from the back of the panels (make a sketch to show where each wire came from). There are 5 wires on the treble panel and 3 on the bass panels. Be very careful when moving the units. They have a thin "cling film" protective dust cover over the entire frame. Watch for dropping "solder blobs" which will drop straight through the panel. Inspect yours closely. Any tears, rips or holes should be rectified with some new dust covers.



Most covers sag periodically, the cure being a heat gun or hair dryer. On the lowest motor speed setting and maximum heat, carefully move around the diaphragm with the heat, and most of the wrinkles will disappear. Sonically, loose grilles equal buzzes, rattles and farts. It is impossible to completely mitigate, you will always have a bit of a buzz. Dust covers are always replaced when replacing a faulty panel.

Damp is the biggest threat to the longevity of the panels. If you put your ear close to the speaker and detect a slight rustling noise, trapped humidity is eating away the conductive paint on your panels. This is the main reason why the panels lose efficiency for no apparent reason. I suppose this is going to be a bigger problem to me than most reading *Sound Practices*. Manchester does have a bit of a reputation as far as damp is concerned.

All of the electronics are screwed to the base of the cabinet. Audio transformer with crossover components soldered underneath to the left, EHT power supply (6000 volts for the bass and 1500 volts for the treble) and mains transformer to the right. On the whole, these are fairly robust. As earlier mentioned, the older EHT units have just about run out of steam, making necessary their replacement. I have seen unserviceable audio transformers, but not many. Their failure is usually due to the speaker being connected to some 4000 watt monster of an amplifier that did not like the difficult load and decided it would eat it instead.

Tweaks and mods are all now pretty well established. For the unacquainted, here's the HTB guide to QUAD tuning:

1) If using a single, use a rigid stand, ideally about 18" to two feet tall. I have seen several different stands for these beasties now, some of which clamp the sides, some of which screw into the sides where the wooden end cheeks are. Most seem pretty competent. Best solution was by a good friend of mine, who built a mini brick wall underneath them.

2) Positioning. Never put an ESL flat against the wall, or running parallel with a wall. Don't forget, as much energy comes out of the rear as comes out of the front. It's wrong to say ESLs are only for large rooms, I've found they work better in small rooms. The most ridiculous was an 7 x 8 foot room. They sounded really great. If you are lucky, and have a bloody big room, best idea is as much space behind them as in front. Keep the beasts a minimum of a metre away from the side walls. On 18 inch stands like this, they really sing.

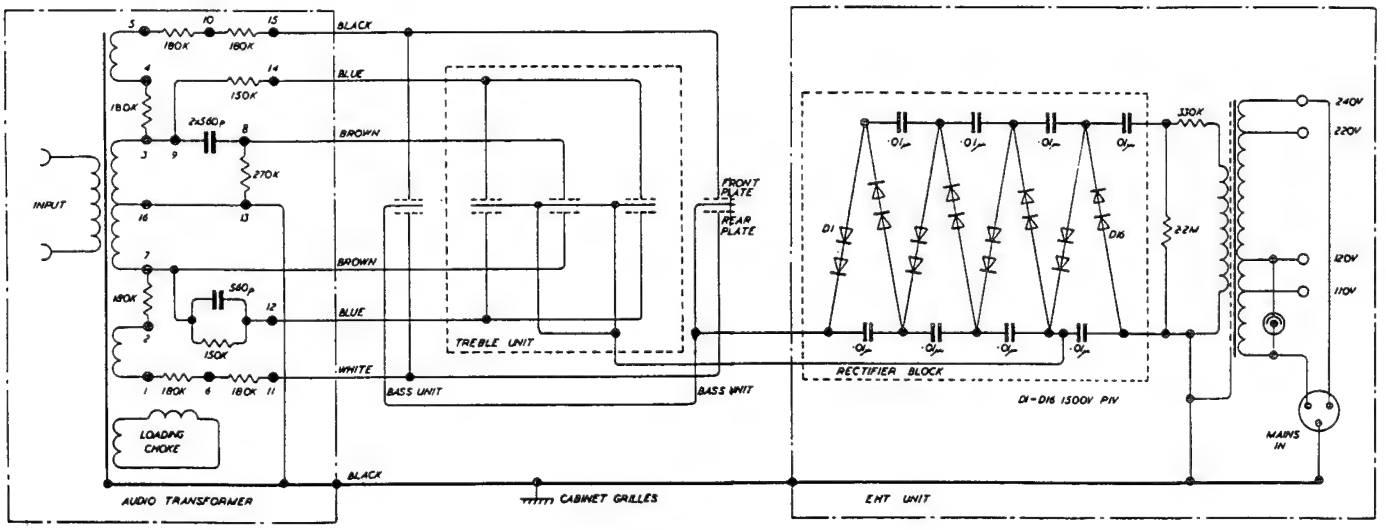
3) Lurking behind the panels are a couple of furry devices designed to stop the sound reflecting back from the wall behind the speaker. With the aforementioned positioning, all our furry little friends do is make the speaker sound dirty. Remove 'em. The items over the bass units resemble sack cloth!

4) Grille removal. Dodgey one this. Not only does it expose the naked panels to the outside world, risking the film dust cover's life, it exposes 4000V to your room, risking some bugger else's life. Like everything else in audio they sound really good naked, but it ain't for the party man or the family man. Tread carefully. Easy to do, see above.

5) New frame. The original frame has a slightly contoured shape. When the panels are securely mounted, they take on this slightly bananas profile. Although this aids dispersion, it does not help the rattles. A new, more rigid frame helps quite a lot. I have built several now, and have taken the opportunity to position the electronics at the bottom in a plinth, with the frame and panel up in the air. Drive units flat.

6) Which leads us nicely to the ultimate QUAD mod, STACKING. Extra efficiency, higher SPLs and deeper bass. Twice the height also equals twice the W.A.F. (sorry Joyce). If you just want to stack an original framed pair, it's quite easy. If you want to be a real smart ass, build complete new frames for both, so you can locate the panels as close as you can together, awesome. Most just stick to the original QUAD recommendations.

7) For those who like to hang upside down, only like the dark, and get miffed if there is not much output past 20 kHz, DECCA ribbons have been used to complement the higher registers. A buddy of mine has horn bass (under the house!) electrostatic mid



Electronic diagram of QUAD ESL

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and ribbon tops, all home made, being driven via single ended transistor. Anyone who thinks this can't work, should think again—it does, really well.

For my ears, the ultimate QUAD setup is a stacked pair in solid frame. One of the best sets I've heard belongs to "Mr. Hard-wired" himself, Glen Croft. Lover of OTLs, No. 1 fan of Julius Futterman (I think Glen has a Futterman shrine buried somewhere in his Erdington workshop), Glen has produced the best sound I have heard out of a quartet of QUADs.

Running without the film dust covers is a very silly idea, this screws the beasts up in a matter of months. Even if it does sound cool.

No, the first commercially produced ESL has a lot going for it. Just watch the reliability. When they were discontinued around 1985, after a production run spanning back to 1956 over 60,000 pairs have been made. The price then was £700 a pair, roughly 60% the cost of the inferior ESL63. Today's price for the '63 is near enough £3000. A rough calculation makes an original ESL worth around £1800. Second-hand, you get laughed at if you ask any more than about £600 for a mint pair. I reckon they are worth triple that.

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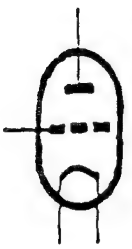
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On the FRONTIER

j.c. morrison reports from the borderlands on the



VAIC VALVE VV30B

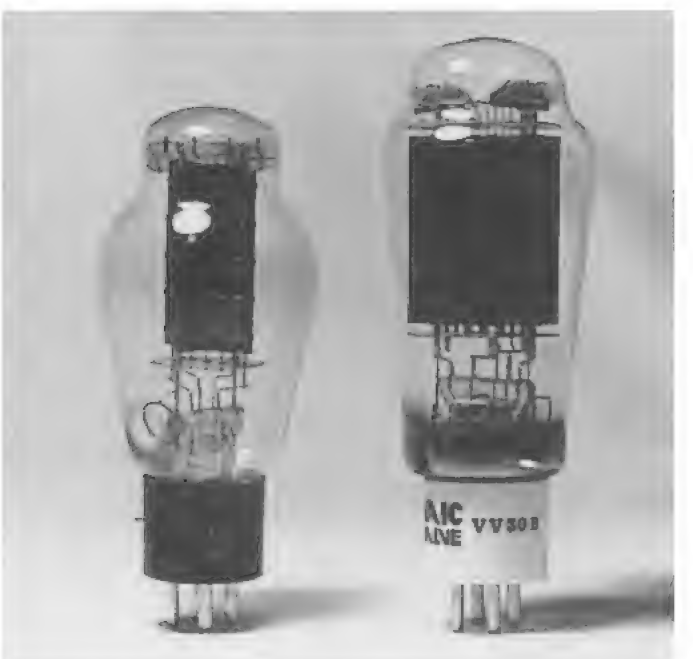
Webster's dictionary defines *frontier* as a border between two countries, that part of a settled civilized country that lies next to an explored or undeveloped region, any new field of learning, thought, etc., or any part of a field that is still incompletely investigated.

So much American culture and style is built on the ideology of an unexplored country, frontier zones are part of almost every discipline. It is curious that the whole notion of the frontiers of "high-end" audio has been carefully dodged for years. Instead, they celebrate the total success of technology in conquering all its mysteries. I can specifically recall the words, "all amps sound the same . . . if you can't measure it, it ain't there." Judging from what you read, even in the more subjective reviews, perfection is at hand or at least within reach of our current practice. Refinement of the existing and suspicion of the truly innovative is the industry hallmark.

I'm not talking only about technology, but more importantly, the way we think ideal hi-fi is supposed to sound. Innovation can also happen between the ears.

One powerful benefit of our constant exploration or curiosity linked to our definition of frontier is the role one plays as a rank beginner in an unfamiliar territory. This status allows an open-mindedness generally hard to come by in the hard knocks, bottom line, status quo, real time world. Open mindedness is what we need to get ahead. The frontier wanderer needs to be careful and pay attention, and especially not take anything for granted.

For example, one area never really explored by the "high-end" is dynamics. With one exception, there is no American speaker manufacturer identified with the "high-end" that makes any product I might even accidentally confuse as dynamic. The exception is notable: David Wilson's X-1 SLAM . . .forget everything else he's made. "Slow and ponderous" is a more accurate general description of nearly all hi-fi speakers and the defense most manufacturers weakly hold out as a response is simply "use more powerful amps." Apogee, for example, recommends 1000 Watts if "real world dynamics are to be



Current production Cetron 300B (left); Vaic VV30B (right)

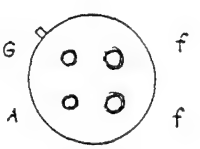
Vaic VV30B Specifications

75 W max plate dissipation
600V max. plate voltage
200 mA max plate current
3.85 amplification factor
700 ohm plate resistance

5V@ 1.2A filament

Plug compatible with 300B

Price: TBA



Manufacturer:
Vaic Valve Italia
via Machiavelli 12/a
Bassano del Grappa
36061 ITALY
(39)424524395 fax

achieved" on its Divas. Forget it, even with 10,000 watts they will flat out refuse to boogie. Compression and group delay are part and parcel of the high end sound. In general, the goals pursued in the last 25 years have primarily centered on a different ideals of "accuracy", namely the *well behaved* kind. The dynamics of musical sound are fundamentally *unruly*.

Reproduction of musical dynamics doesn't pose a problem for contemporary engineering, the difficulty is that the idea does not fit with the expectations of ideal "high-end" sound. Dynamics are taken totally for granted in the pro sound arena. As a for instance, Altec 604s may not be my idea of a great sound but even this utterly conventional studio monitor vastly outperforms all high-end contenders in terms of realistic reproduction of dynamics. It should not be a controversial thing to point to this as a legitimate "yet" for hi-fi audio. Jump factor and air-moving capacity do not even belong to the high end vocabulary for most audiophiles. Mini monitors anyone?

Another unacknowledged frontier for the "high-end" is active devices. It is true that the "comeback" of the triode amplifier enhanced the repertoire of the adventurous designer, yet real innovation in circuits and application have occurred mostly on the fringes. Most of the "pro" players are using reintroduced traditional approaches, using components designed over a half a century ago. Sure these devices are good enough to compete sonically with anything from the Seventies and Eighties but why don't we really push the envelope?

What about the possibility of NEW vacuum tube design? The KT-90 and 99 are only black comedy as far as I'm concerned. The issue was unaddressed in any serious assault — until now.

Vaic VV30B

The first NEW directly heated audio power triode in more than 30 years was revealed at the Milano "Top Audio" show In October. Rumors have been flying around for a while, but I not only saw a crate of samples and heard them plugged into an Audio Note Kassai, I met the people responsible for it and managed to snatch a few specimens for testing and listening. You might find the story interesting, no?

A few months ago, Peter Qvortrup of Audio Note invited Herb Reichert and me to tag along on one of his constant audio road trips. This one went from Brighton to Paris then to the audio show in Milano.

Peter is as lost in high fever land as any of the lead poisoned triode freaks I run with. His funky bungalow in Brighton has hot and cold running people and children and music playing all the time. Heated discussions take place until late at night and start up again early in the morning. He has twenty thousand records at least, which are played through a combination of Audio Note gear and various experimental "bits" as he likes to call them. I didn't sleep at all for the first 48 hours.

The trip began in earnest when we reached Calais. Peter revved his Mercedes station wagon up to 125 mph and kept it there pretty much the whole time. Maybe he gunned it once or twice to pass someone. The guy's a total leadfoot. Istvan and Handoko, representing Audio Note Hungary and Indonesia respectively, were the other two nutjob passengers on this excursion. We ran into some organizational problem with the Paris show so, after scarfing down a North African snack, decided to press on to Milano directly. Twenty expressos later, the sun came up as we raced through the Alps towards the Chamonix tunnel and Italia. We were in Milano by ten.

Bleary eyed and partly flatlined, me and Herb staggered around the hotel trying to find a quiet corner to doze off for a minute, when Peter came to drag us off to the Audio Note room. Qvortrup thrives on sleep deprivation. Anyway, to cut to the chase, standing in the doorway was a well-dressed older gentleman, energetically waving his arms for emphasis, firing away in rapid fire Italian at a small group crowded around him. Peter introduced us to Dr. Ricardo Kron, tube manufacturer.

Over the next few days, I had several opportunities to speak with Dr. Kron, his wife, Mrs. Eunice Kron, and with their interpretive services, Alesa Vaic (pronounced "vaish"). They are the principals behind the Vaic VV30B, a totally new power triode designed as a drop in replacement for a 300B.

Dr. Kron was born in Northern Italy, a while ago. He was crazy about radio and hi-fi in its early days and was actually hired by Leak to install Toscanini's first system. Kron is today what we call here in America a real radio man. Scrounging around in European hamfests a few years ago he ran into a very young Czech tube man who was selling replicas of early radio valves. He made them himself. Kron and Vaic hit it off and began a small business selling Marconi "I" valves and limited production replicas of various 1918-1923 vintage valves. Total production numbered about 3000 pieces and they sold all over Europe and Asia as well.



Vaic handmade replica of a Marconi "I" valve. What a hobby!



Dr. Kron and Alesa Vaic at the Milano "Top Audio" Hi-Fi show

The VV30B is constructed of 98 separate pieces. Special jigs are required for assembly because of the close spacing — 400 operations are necessary to complete one tube. The geometry is critical and the construction is sophisticated, equaling or surpassing the craziest of Western Electric tubes (417A, 418, 436, 437A , etc.).

Vaic told me that without the help of his buddy, Filip Macek on computers, and four old salty dogs from Tesla, the project may never have succeeded. The glass specialists particularly, Ladislav Krouzel and Antonin Procnazka, who have 40 years experience making tubes, gave the ultimate push that brought the VV30B from design to reality. Vaic, Macek, Krouzel, Procnazka, Miroslav Kvapil (cathode specialist) and Pavel Bena (mechanical) make up the main production team.

Alesa Vaic is now twenty eight years old. A graduate of the University of Prague in electrical engineering, his specialty is in thermionic materials and electrical measurements. Vaic is really passionate about vacuum tubes. His familiarity with the history of Western Electric's entire tube production, and all tube technology for that matter, is shocking. He's like a walking encyclopedia who likes good food and drinks lots of beer. His internship at Tesla's experimental laboratory gave him the opportunity to hone his skills and network the best oldtimers for high grade tricks and new technologies.

Two years ago, because of the heightened attention on the 300B in Europe, Kron began broaching the subject of getting really serious about business and perhaps producing a local 300B. After looking at the market, Vaic and Kron decided to design a new triode power tube instead of a retrofit. Their initial criteria was to take advantage of the most up to date innovations in materials, chemistry and engineering. A recent Japanese technology for constructing anode materials allowed for an increase of max dissipation without increasing size. The Tesla archives were pillaged for their best data. Vaic also tried out some new ideas.

The "old way" of developing a tube depended on a mathematical model which was empirically modified. Vaic, together with friends from the university made a computer model and tested it against materials at the department of metallurgical studies in Prague. A novel, and now patented, filament construction of Vaic's own design, was developed to improve both the quality and the quantity of emission.

The VV30B filament is constructed of a double ribbon paralleled in eight flat sections, which provide a total of 32 emissive surfaces. The cathode emission is exactly the same at all points for AC or DC operation. The flat filament directs current in a planar fashion, so side and secondary emission are almost eliminated. Additionally, the distance between grid and plate can be reduced to minimize transit time and lower impedance. A year and a half of computer modeling plus six months of engineering were necessary before the first production was completed at Tesla's research facility.

The VV30B is physically impressive, the lead crystal glass and ceramic base are beautiful. The plate construction resembles the Siemens "Ed" — the German answer to the English PX-25, and one of the most highly regarded power triodes of all time. When I mentioned this resemblance to Vaic he smiled coyly.

The VV30B plate is a fraction of the size of that in any 75 watt tube I'm familiar with. The directly heated cathode construction is completely encased by the plate and large barkhausen plates are visible at the top of the siderods. Vaic told me that the cathode filament is three meters long! The filament is rated at 5 volts 1.2 amps so it will drop into any 300B amplifier. I have mentioned the 75 watt plate dissipation, but this comes with a max plate voltage of 600 volts and a max plate current of 200 milliamps — whichever you reach first!

Dr. Kron was very generous to give me some samples of the tube to bring back for testing and review. As soon as I got home, I called in celebrity tube photographer Steve Berger to take some snaps for this article then I sent a pair over to Lynn Olson and Matt Kamna in Oregon for running characteristic curves and general testing. Arthur Loesch brought in a new parallel single amp for 300Bs that we (Herb, Bob Cummings, A. L. and myself) eagerly tested with the new tubes. The stuff ROCKS! I left two pairs with Arthur to bring back home and we're expecting a detailed report from him soon.

My initial impressions of the VV30B, specifically compared to Western 300Bs, are that they have a similar harmonic signature. However, the VV30B flushes out more information at low dynamic values. There are more colors and more ambient information, and in general it could be said to provide a richer recovery. Still, the basic character is very similar to the 300B. Is it an improvement? Yes, I think it is.

This brief article should be understood as only an introduction. Many people will have a lot more to say about this development in the near future once overseas distribution arrangements are worked out and full production gets underway. The manufacturer expects

that the VV30B will be available in the States by February 1995. The first production run went to Japan where obviously it attracted a lot of attention in the local audiomania community. The VV30B will be a limited production product more or less in the same price league as select grade 300Bs, so it won't be the plentiful and cheap tube that I hope to see coming out of Russia someday. But if it doesn't say Vaic it ain't a VV30B.

Time is needed to really explore the possibilities but I'd be lying if I didn't admit my excitement about new tubes. Audio needs more of this, really. The frontier starts right here.

Notes on the Plate Curves
by Lynn Olson and Matt Kamna

Since the graphs are bafflingly similar, the only real way to compare them is to make full-size photocopies, overlay a pair of graphs together, shine a bright light through them, and slide the horizontal (voltage) axis back and forth until the -60V grid-lines overlap. Then the differences become more apparent, particularly in the low-current regions.

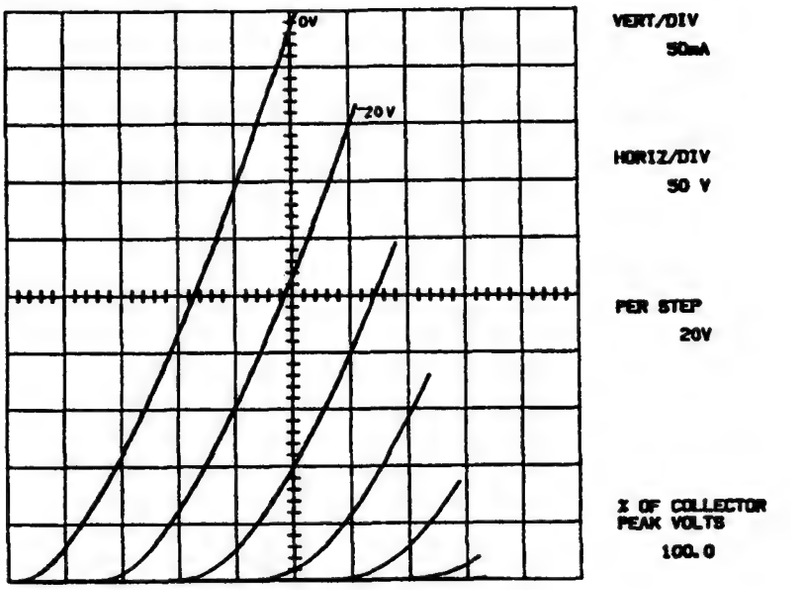
Note the startling similarity of the Sylvania 2A3 graph to the VV30B, with both exhibiting very good low-current linearity. In a perfect tube, the grid-lines would all be parallel (indicating equal Rp at all drive levels) and equally spaced (indicating equal gain at all drive levels). This is where the 2A3 and the VV30B show an advantage over the other types on close examination.

The Shugang tubes show some odd behavior at very high current levels (although this region would only be traversed in a near-short-circuit condition). This phenomenon is possibly due to the tube running out of emission. This guess is based on the power consumption of the filament being on the low side compared to all of the other 300Bs under test. Another possible explanation is grid-current starting to flow due to gas in the tube and causing the HV amp to current-limit (this explanation seems like a bit of a long-shot, however).

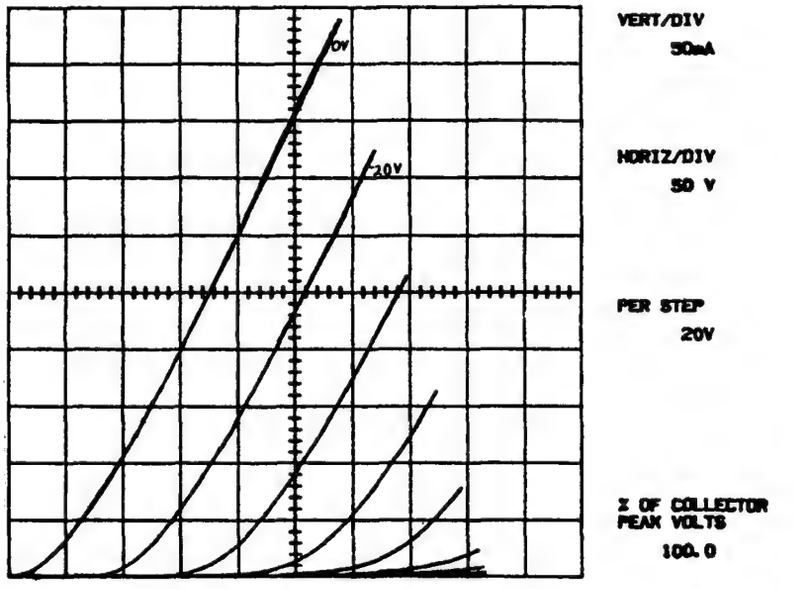
J. C. Morrison's preference for high current operation becomes much more obvious with this data. The behaviour in the low-current region *really is* pretty bad, with high-order distortion implicit in the highly-curved regions of the graphs.

Based on this data, it appears appropriate to push the quiescent current as high as tube longevity permits — thus calling for moderate plate voltages, transformer primary impedances that are on the low side, and as much current as possible (instead of the usual 60mA, 80-90mA looks better for the 300Bs). This does get you a little closer to the grid-current cutoff, but it also gets the quiescent operating point much further away from the really nonlinear low-current region.

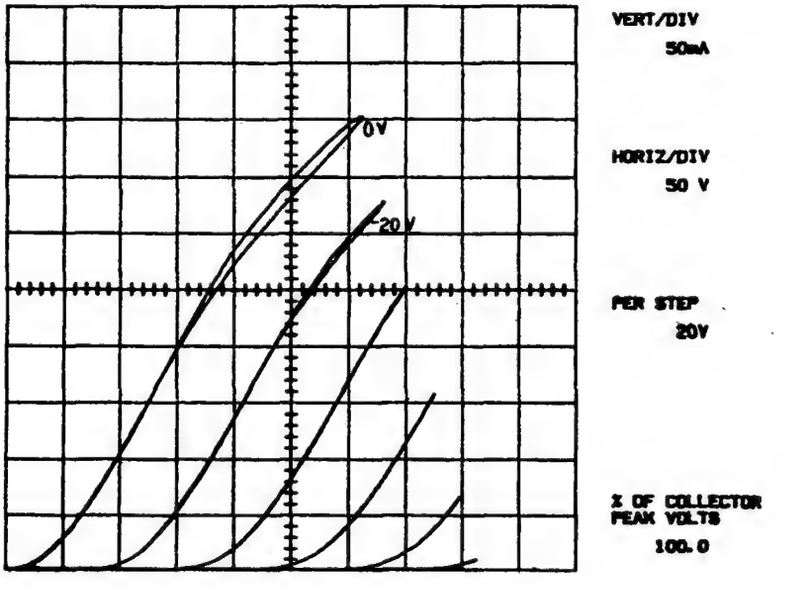
Vaic VV30B Plate Curves



Used WE300B



Shugang 300B



Remember, the brief 1-10mSec peaks in music are 20-30dB higher than the average level, and the ambient reverberation is 40-60dB below that. So in reality, the tube spends 95-99% of its time staying very close to the quiescent operating point, with only very occasional excursions away from it. If the immediate region around the quiescent operating point is free of high-order distortion, the subjective sound will be much more relaxed and natural at normal listening levels.

Folks who are unfortunate enough to own garden-variety audiophile speakers (efficiency from 82-87dB/metre) are out of luck, since those speakers require 30 to 150 watts to really get motivated. (That's why I designed the Ariels for the Oregon Triode Society — 92dB/metre at least opens the door to moderate-power triode amplifiers, and the builders don't have to make a whole-hog commitment to multi-amped horn systems.)

In future months, Matt and I intend to do real comprehensive measurements that compare the harmonic spectra of the various 300Bs and 2A3s out to the 11th harmonic. We'll use a spreadsheet program to isolate the even and odd harmonics and chart the harmonic spectra. We did this with an SRPP project earlier in the year and it proved to be interesting.

We extend our thanks to J.C. Morrison, VAIC Valve, Tektronix, Linear Technology and Burr-Brown for assistance in making this project possible.

Test Protocol for Directly Heated Triodes →

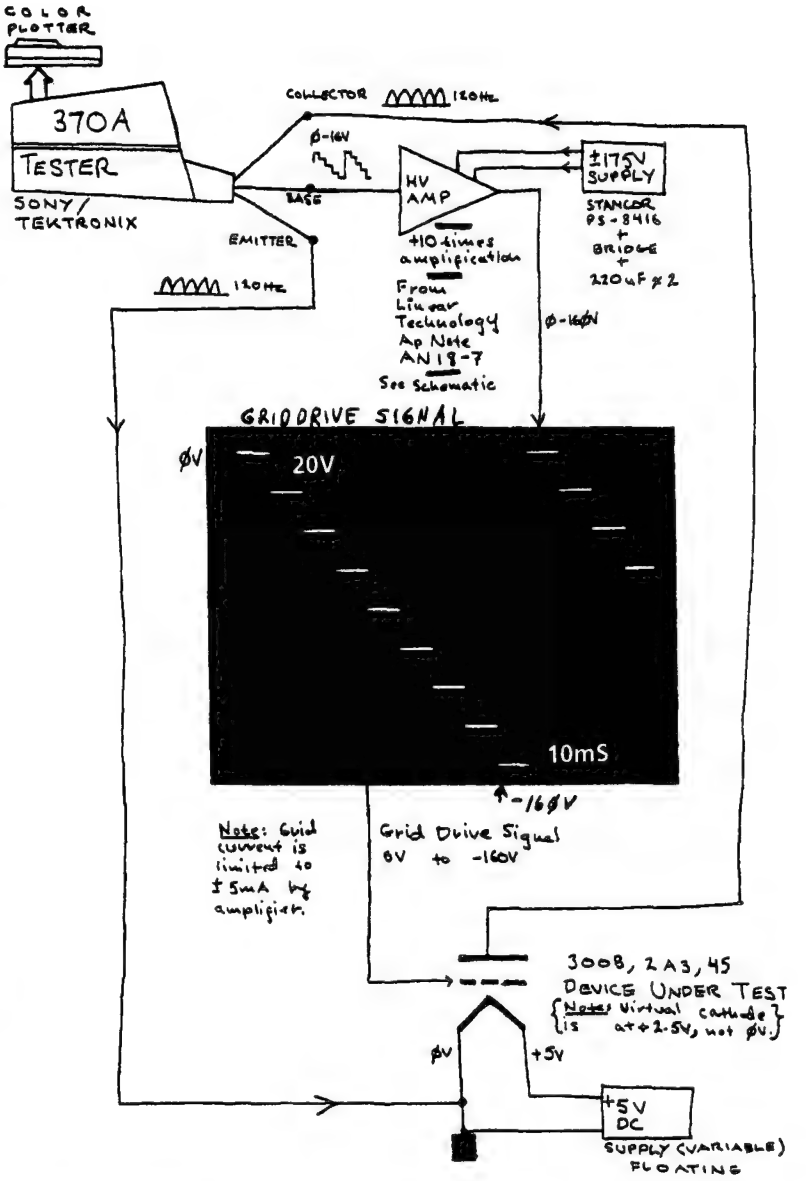
Test settings for 370A

Vert = 50 mA/div.

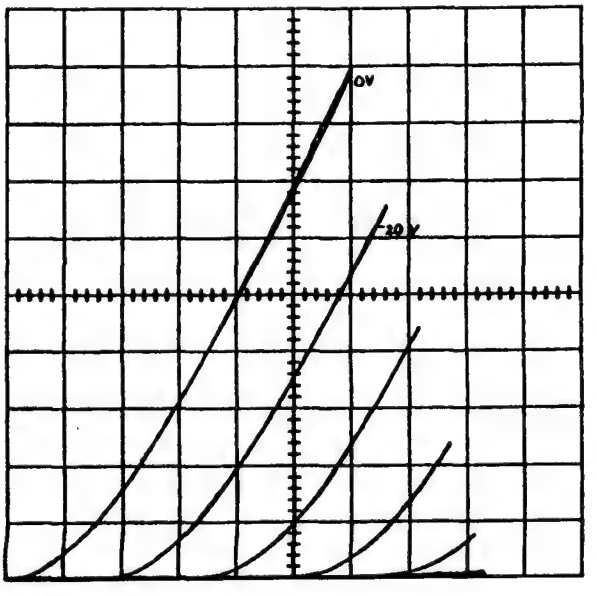
Horiz = 50V/div

Step = 2V (multiplied to 20V by ext. amplifier)

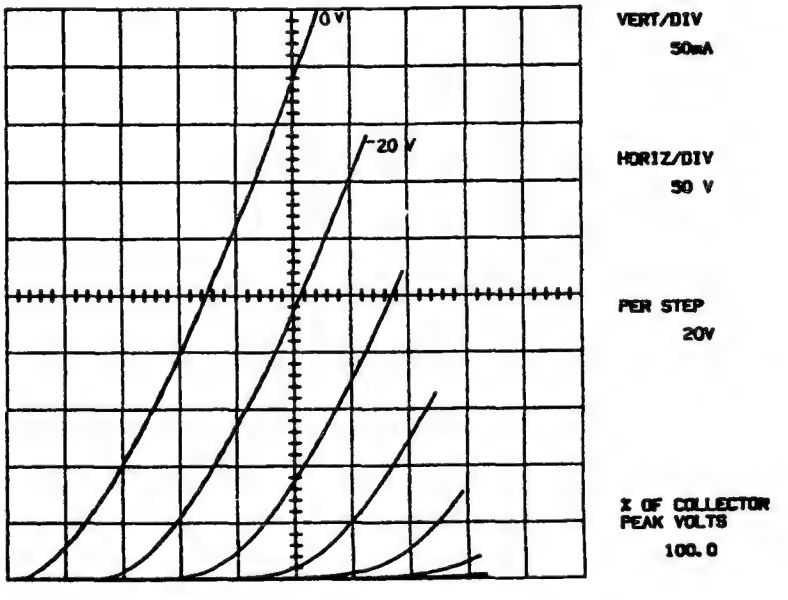
Step # = 8 steps



Used Sylvania 2A3



Cetron 300B



SUGGESTED SE TRIODE AMPLIFIER CIRCUITS



one electron

Electra-Print Co.

Here's what transformer makers are building for themselves

ONE ELECTRON SEA-1 TRIPLE 2A3 AMPLIFIER

by John Atwood, one electron

The SEA-1 amplifier is a straightforward single-ended audio power amplifier that delivers about 11 watts, using only medium and low-mu triodes. No negative feedback is used, other than local cathode degeneration. No voltage regulation or semiconductors are used in the design. The sound of the amplifier is characteristic of triodes: smooth and detailed. Despite the lack of feedback, the bass is surprisingly solid. This amplifier has been tested on a variety of speakers, and no incompatibilities have been found, except, of course, the need for relatively efficient speakers (approx. 90 dB/watt or better).

The SEA-1 was designed to evaluate the prototypes of the UBT-1 transformers. In order to provide flexibility in testing, the SEA-1 was designed to be used with a separate external power supply. There is no reason why the power supply could not be included on the same chassis as the amplifier, as long as hum inducing components, such as power transformers, are kept away from the amplifier driver circuits. The supply needs to provide 395 volts DC at 160 mA, and 6.3 volts AC at 1.8 Amps. Filtering is not critical, since filter chokes are incorporated into the amplifier. A surplus Dressen-Barnes model 30180 "Unregulated Power Supply" was used for each channel in the SEA-1 prototypes. A simple capacitor or choke-input power supply, as described in the *RCA Receiving Tube Manual* or *Radiotron Designer's Handbook*, can be used.

Note that this amplifier description is intended to aid experienced tube amplifier designers and builders. People with little experience building vacuum tube audio amplifiers should not attempt to build this amplifier based on just this description. The voltages used in this amplifier are lethal; precautions for working on high voltage equipment must be followed.

Circuit Operation

Choke-capacitor filters are used for both the output and driver stages. Separating the power supply filtering this way reduces feedback from the output to the driver, and helps insure the highest possible B+ voltage to driver tube V2. Locating the filter chokes on the amplifier chassis instead of the power supply helps isolate the amplifier from external noise. Every electrolytic capacitor is paralleled with a film capacitor. R20 is a bleeder resistor to help drain the filter capacitors when powered-down.

The input stage is a conventional resistance-coupled amplifier using the octal 6J5 or 6C5. The metal version is preferred here, due to the electrical and magnetic shielding of the envelope. The cathode is only partly bypassed. The ratio of R3 and R4 was chosen to give an overall amplifier sensitivity of 22 dB.

The second driver stage, using paralleled sections of a 6BL7GTA, has the difficult task of driving the highly capacitive inputs of the three 2A3s at up to 100 volts peak-to-peak. Despite the relatively low plate resistor of 12.1K, this stage is still the limiting factor in the overall high frequency response. To help prop up the response and reduce phase shift at high frequencies, the "unbypassed" cathode resistors of V1 and V2 have small compensation capacitors, C1 and C8, which were chosen experimentally to give the flattest overall frequency and phase response.

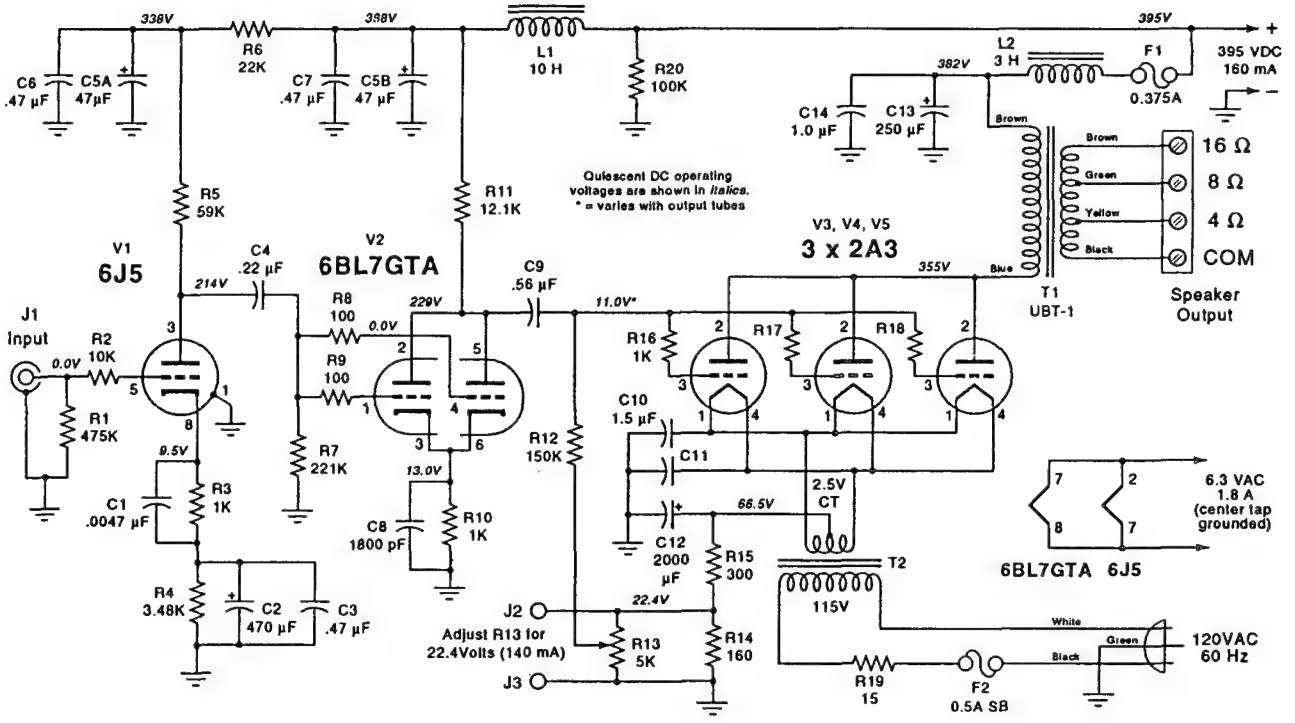
The output stage is cathode biased, with about 20 volts extra drop in the cathode resistors to allow a bias adjustment, using R13. Medium and low frequencies are bypassed around the cathode resistors R14 and R15 by the 2000 mF capacitor, C12, at the center-tap of the 2.5V filament transformer. High frequencies are bypassed by C10 and C11 from each filament terminal to ground. This keeps high frequencies from flowing through the filament transformer and helps filter out power-line noise.

The resistors R8, R9, and R16-18 are intended to suppress parasitic oscillations. R2 helps protect the input stage from RF overloading on the input.

As with most American power transformers, the primary of T2 is rated at 115 volts, whereas the average power-line voltage in the United States is 120 volts. In order to keep the output tube filaments at the correct voltage, R19 was added in series with the primary to drop the filament voltage. Since your average power-line voltage may vary, R19 should be chosen so that 2.5 volts RMS appears on the 2A3 filaments. Similarly, resistance may be needed in the 6.3 volt filament supply. In the prototype, the wire resistance of the connecting cable supplied the correct resistance.

Variations

V1 could be replaced by a 6C4, 1/2 of a 6SN7, 1/2 of a 6FQ7, or 1/2 of a 12AU7. There is no direct replacement for V2, although two 6S4 in parallel or a 5687 should work (but these have not been tested). Replacing the 2A3s with 6A3s or 6B4Gs will cause excessive hum and is not recommended unless their filaments are run from a DC supply.

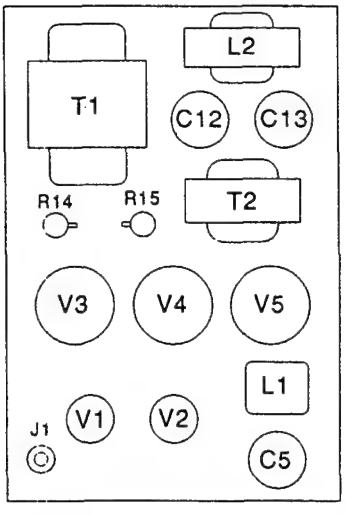


C1 – .0047 µF 100V Polypropylene
C2 – 470 µF 25V Low-ESR Electrolytic
C3 – 0.47 µF 100V Polypropylene
C4 – 0.22 µF 400V Polypropylene
C5 – 2 x 47 µF 500V Audio-grade Electrolytic
C6, C7 – 0.47 µF 600V Polyester
C8 – 1800 pF Glass or Mica
C9 – 0.56 µF 400V Polypropylene
C10, C11 – 1.5 µF 250V Polypropylene
C12 – 2000 µF 75V Computer-grade Electrolytic
C13 – 250 µF 450V Computer-grade Electrolytic
C14 – 1.0 µF 630V Polypropylene
F1 – 0.375A type 3AG fuse
F2 – 0.5A type 3AG Slow-Blow fuse
J1 – RCA-type phono jack
J2 – Red pin jack
J3 – Black pin jack
L1 – 10H, 30 mA, 515Ω Choke (Merit C-5503 or equivalent)
L2 – 3H, 150 mA, 90Ω Choke (Stancor C-2309 or equivalent)
R1 – 475K 1/4W Carbon Film
R2 – 10K 1/4W Metal Film
R3 – 1K 1/2W Metal Film
R4 – 3.48K 1/4W Metal Film
R5 – 59K 1/2W Metal Film
R6 – 22K 1W Carbon Comp.
R7 – 221K 1/4W Metal Film
R8, R9 – 100 1/4W Carbon Comp.
R10 – 1K 1/2W Metal Film
R11 – 12.1K 2W Metal Film
R12 – 150K 1/2W Metal Film
R13 – 5K 2W Potentiometer
R14 – 160 1% 10W Wirewound
R15 – 300 20W Wirewound
R16, R17, R18 – 1K 1/2W Carbon Comp.
R19 – 15 5W Wirewound
R20 – 100K 3W Metal Oxide
T1 – 1600Ω, 160mA primary to 4/8/16Ω output transformer (One Electron UBT-1)
T2 – 2.5VCT, 10A filament transformer (Triad/Magnatek F-3X or equivalent)

Unless otherwise noted, all resistances are in ohms.
Star grounding is not shown.

SEA-1 – Triple-2A3 Amplifier

rev 1, 8/94, One Electron



SEA-1 Chassis Layout, Top View

Measurements

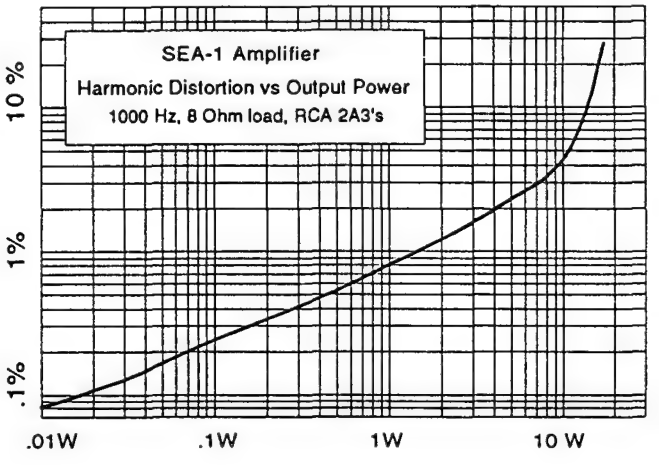
Frequency Response: 10 Hz to 44.5 KHz (-3dB at 1W)

Output Power and Harmonic Distortion: see graph at right.

Sensitivity: 22 dB (to 8 ohm tap)

Damping Factor: 3.5

All measurements were made into a low inductance 8 ohm resistor connected to the 8 ohm output tap.



Most component values are not critical. In fact, all components except the plate and cathode resistors and the compensating capacitors C1 and C8 could vary by as much as 50% without seriously affecting the amplifier's operation. The plate and cathode resistors should be chosen within 10% of the values shown. If R14 is not 160 ohms, then the bias adjustment voltage should be altered to give 140 mA through the output tubes. If a stereo pair of amplifiers is being built, component values should be matched between amplifiers to insure identical responses.

The component types specified on the schematic were chosen to give a clean sound, while still using common parts. However, experimenting with different types of components (i.e. oil-filled capacitors instead of polypropylene or bulk-foil resistors instead of metal film) is encouraged. Since there is no feedback, parts differences will be more noticeable than with feedback amps.

Output Tube Notes

Traditional American 2A3s, by RCA, Sylvania, Tung-Sol, etc. give the highest output power and lowest measured distortion. However, they are very hard to find, and are quite expensive. The "Sino" 2A3s (made in China) are readily available at a reasonable price, but give slightly less power and higher measured distortion. In many listening tests with the SEA-1 prototypes, however, the Chinese tubes sounded better than the American tubes!

A problem has been noted with the Sino 2A3s: occasional erratic popping, buzzing, or squealing noises. This tends to happen when they are first warming up, but sometimes persists indefinitely. These sounds are generally not microphonic, but appear to be caused by a chaotic metastable condition of the electric fields inside the tube. This seems to diminish over time, but in bad cases, the offending tube must be replaced.

Construction Notes

Construction is not critical, except to observe general good layout rules, such as keeping high signal voltage points (such as the plates of V3 through V5, and the power line), and power transformers and chokes, away from the input stage. The filament wires to V1 and V2 should be twisted and kept close to the chassis.

A variation on "star-grounding" is recommended: connect all grounds related to V1 and V2 (including C5 through C7) to one point, and all grounds related to the output stage (including C13 and C14) to another point. These two star grounds are then connected together, and tied to the chassis at a ***single*** point between the input and output.

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65 Washington Street, Suite 137
Santa Clara, CA 95050

ELECTRA-PRINT 300B SE

by Jack Elliano, Electra-Print Audio

During the 1970s, my incomparable Uncle Hank told me about the sound system in the motion picture theater he owned in the '40s. "Those 45s in the output were made for good speakers," he said. The gunshots, the cannons, the music, hundreds of people escaping to another time and place for a few hours, they never questioned the sound. "What they heard was what they saw."

I never forgot what Uncle Hank said but, being young then, all I knew was that Frank Zappa was running 200 watts with his transistorized Sun guitar amps. Now that's audio!

While working at Litton Industries, Guidance and Control Systems Division in the 60s I met Cy Brenneman. Cy had just installed a dynamotor powered Williamson amplifier playing into a pair of 8" Jensen coaxial speakers mounted in the trunk of his car. Cy's love for "home-brew" tube gear was inherited from his father who still swore by his old push-pull 6A3s in his living room.

Both Cy and I worked with state of the art tube operated test gear in our day jobs. Calibration and troubleshooting this equipment showed us tube circuitry that defies logic. As time passed, Cy moved on to manage an NBS traceable calibration lab and I went to Project Gemini and designed all-tube recording equipment on the side. We kept in touch over the years.

One day, Cy suggested that we check into these single-ended triode amps that were then very popular in Japan. Good for maybe 7.5 watts of very high quality audio. "Wow man, will I need to change my circuit breakers?" I asked.

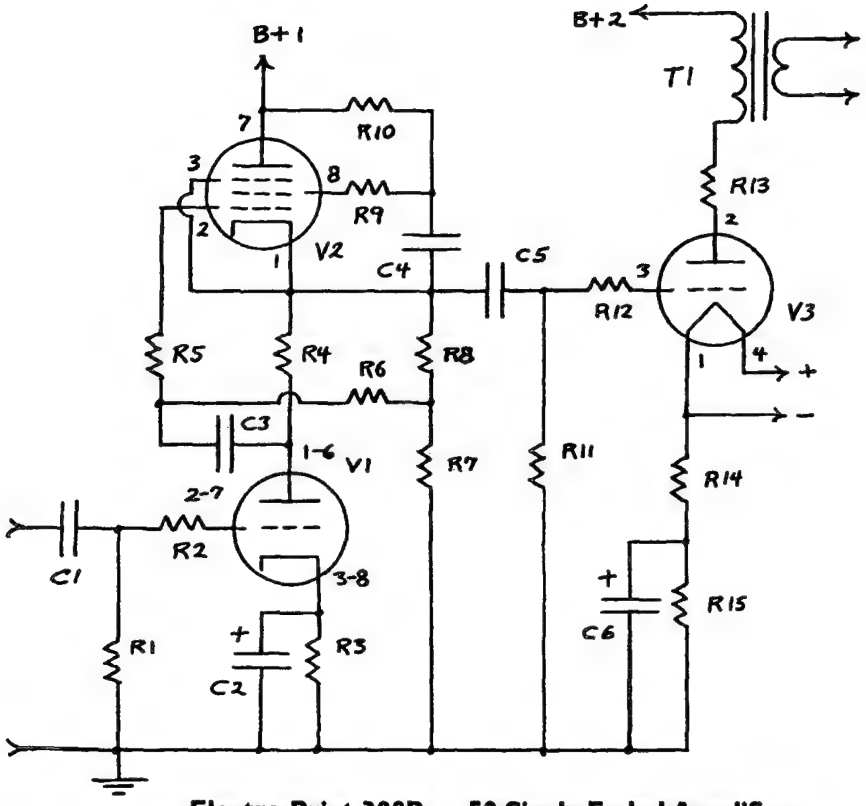
Well, I did check it out. I discovered that push-pull cancels all even-order harmonics of the signal and produces its own waveform. Single-ended class A reproduces the total signal including all harmonics. That got me off the couch! I bet that sounds as good as hearing all your lotto numbers being called out by Sharon Stone. So we plugged in the soldering irons and got to work.

Designing a driver stage to hold up to the infamous grid of a power triode led us to consider the renowned cathode follower. An improved version, the Mu Stage, described in *Glass Audio*, Feb. '93, by Alan Kimmel, appeared to hold definite possibilities. We built it and the search for perfection had begun. At this point we had a very low impedance, high output, wideband and distortion free driver. However, passing this super signal through a push-pull 300B output stage yielded disappointing results. 'Twas the time to seek the Triode lore of old, single ended.

Cy introduced me to Paul Bennett, a consulting engineer, with an extensive background in audio, dating back to the early 30s. Paul (who must have been born on the same day as was the vacuum tube) came to the rescue with wisdom very few possess. His knowledge gained during the tube era and his understanding of what we were up against, resulted in hours of heated discussion on audio theories, concepts, and myths.

We agreed on a concept that a power triode with its driver, an output transformer, and a speaker must work together as a team to keep the applied signal from becoming modified in the tube's non-linear regions. Paul said, "Ponder this analogy (dig this): think of a power output triode as a variable resistor, a rheostat with two shafts, one controlling the wiper and the other changing the total resistance. A tube's plate resistance changes with grid drive (or bias); the load changes with speaker motion. The output transformer, of course, sits in the middle of the whole thing."

We knew that to pull off what we were trying to do, we would need an exceptionally well designed SE transformer. A search for this elusive device led us to realize that it did not exist. Well that dumped "dog-doo" on our donuts! We would have to build our own. Paul grinned, then said, "With the specs you're demanding, I hope you know some black magic, because as far as I know its never been done, even by the big boys." The quest was on, and we divided up the projects. Cy worked on the circuitry with



Electra-Print 300B or 50 Single Ended Amplifier

Parts List

	R1	47K
	R2,R5,R9	150
*	R3	910
	R4	40K 5W
	R6	1meg
*	R7	20K 5W
*	R8	220
	R10	47K 2W
	R11	51K 1W
	R12	1K
	R13	10
*	R14	440 5W
*	R15	390 5W

*approximate value
All are 1/2 watt unless specified.

C1	1mf 200V high quality
C2	500mf 10V elect.
C3	.33mf 400V high quality
C4	.68mf 400V
C5	1.5mf 400V high quality
C6	500mf 50V elect.

V1	6AQ8
V2	12HG7
V3	300B or 50

High voltage requirements:

B+1	650V reg. 25ma.
B+2	475V reg. 100ma.

Filament:

V1	6vdc .5a
V2	12vdc .5a (isolated 325V)
V3	5vdc 1.5a reg. slow start
V3	7.5vdc 1.5a

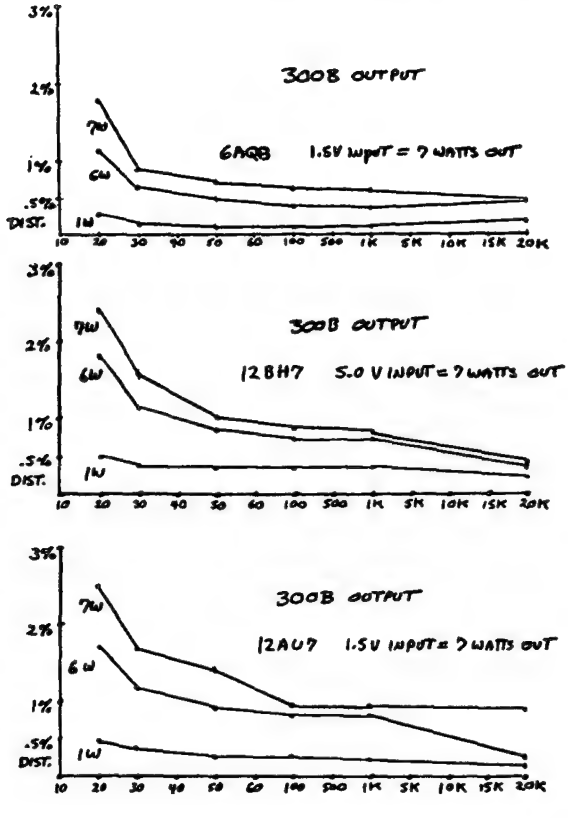


Fig. 1— Distortion curves for 6AQ8, 12BH7 and 12AU7 with above circuit

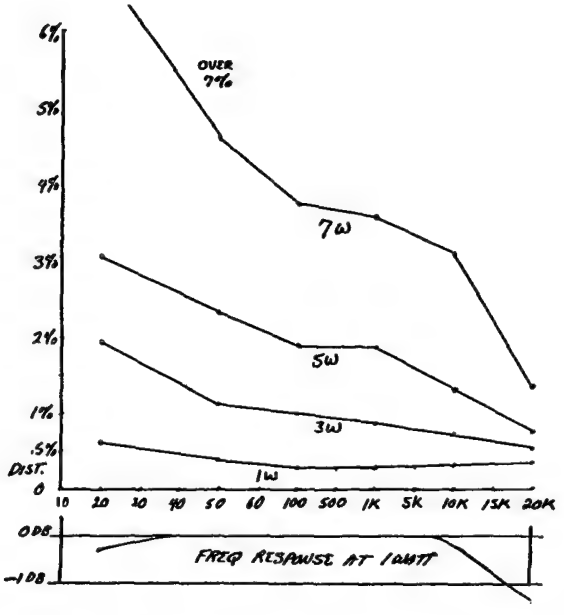


Fig. 2 — 300B SE amp with conventional driver circuit

the top quality audio test gear he accrued over the years, and I worked on the transformer designs.

Until the transformer was complete, Cy kept busy with driver circuit design, evaluation of input tubes and regulated power supplies. I wrestled with the many variable factors to be considered in design of a transformer: proper choice of material and size of core, wire size, fill, number of turns, countless configurations of interleaving and control of interwinding capacity. Each one affects the overall performance of the output system.

This transformer had to be approached as a system, the blending of many disciplines. We needed a large core mass due to the continuous DC plate current and to allow headroom for the signal. After eight months and many pounds of magnet wire all went well. Believe me, the satisfaction of finding a $20 bill as you step out of your car is nothing compared to hearing a transformer you wound working beautifully.

The output measurements were as good as any 300B could produce, but Cy still was not satisfied. A fact of life exists that all power triodes due to their electrostatic geometry, produce second harmonic distortion. This type of distortion created by the output stage is undesirable; however the output stage must reproduce even as well as odd harmonics from the signal source. Output tube generated second harmonic distortion can only be minimized by increasing the load impedance into the lower power portion of the tube; therefore the distortion goes down, but it still exists.

One problem we pondered was how to eliminate the tube generated second harmonic without the use of feedback. Cy worked on this while I worked on transformer design. He came up with a driver stage that would duplicate the second harmonic distortion 180 degrees out of phase to be fed into the output tube to cancel the unwanted distortion.

This theory was based on the fact that when the driver was deliberately distorted in a certain way and this signal was applied to the output grid, the resulting distortion figure at the output was an order of magnitude lower. The distortion was "nulled out." It also appeared that no phase shift type distortion was present proving that the distortion is manufactured by a tube and not a reactive component. It is important to have an output transformer that will not add its own distortion at 20Hz. Therefore the distortion at the extreme high and low end is the result of reactive components.

After trying just about every triode input tube known to man, the choice narrowed down to a 6AQ8 with a 12HG7 as a current source/cathode follower. This marriage gave the best results using a Western Electric 300B. And with slight variations of a few resistor values, it worked with a type 50 also. We tried all the audio standards, 12AU7, 6SN7, 12BH7, 6DJ8, etc. and others with very little nulling effect on the output.

The amplifier output distortion results of several driver tubes are shown in fig. 1 A, B, C. The distortion chart of the 6AQ8 (fig. 1A) shows the dramatic difference compared to a conventional 300B amplifier (fig. 2) using a conventional drive circuit.

We arrived at these measurements by first setting the output tube operating point at 40 watts plate dissipation. With a low distortion source on the input and a distortion analyzer on the output, we fine tune resistor values until the distortion and power figures are best. Optimal resistor values change from tube to tube. We discovered that starting the test procedure at the low end of the spectrum had a definite advantage overall, due to the reactive components at that frequency starting to affect the performance.

The schematic of the amplifier provided here does not include the regulated high voltage supplies which are a must for this type of amplifier. The regulated supplies offer voltage stabilization and ripple rejection for a solid low end. Also not shown is a slow start regulated filament supply needed to minimize hum and to "make love" to your precious 300B.

We all had worked with tube audio for most of our lives and we were IMPRESSED beyond all expectations. When we tried an early version of this amp on Bruce Edgar's horn system we knew that we were on the right road. Single ended triode sound had instantly flushed all push-pull tube, solid state, and tetrode powered amplifiers down the tubes, as far as I was concerned.

I figured it was mostly the result of no feedback but there was more to it. Our discussion and theories about the tube, transformer and speaker working as a team and that the transformer is in the middle of all this impedance changing, has merit. The transformer with its relatively steady flux can reflect any impedance change instantly as opposed to a push-pull core, reluctantly swinging up from zero flux on the half cycle and trying to stay in motion, then starting all over again in the opposite direction, canceling all even order harmonics and giving you a nice and powerful but *different* waveform.

Go ahead! Remove the feedback from a push-pull class AB amp and measure the distortion and damping factor. My money is on single ended triodes because of two plain facts: the speaker moves and the plate resistance changes with grid drive.

Since all of us are in the audio business, it seems proper to offer a well designed product for sale. After all, capitalism is still legal. The transformers are available through Electra-Print Company, as well as details on the driver circuit distortion and null adjustment procedure. We recommend C3K for 300B or parallel 2A3s or M5K for type 50s.

In closing, we the above described FBEs (fire bottle engineers) cannot emphasize the pleasure and camaraderie that comes with such an absorbing project. We know there is always room for improvement, so until they confiscate our soldering irons, we will continue the quest.

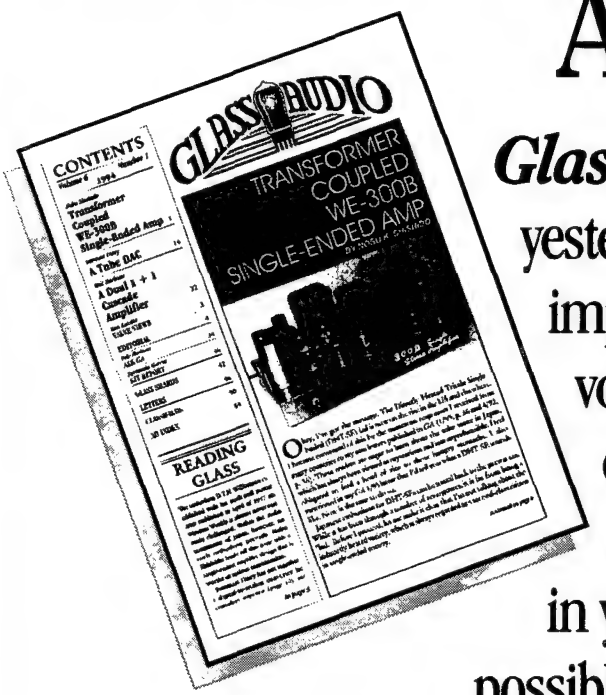
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USE THOSE "JUNK BOX" CHOKES!

Salvage those unidentified parts by running tests to determine their electrical characteristics

by Sherman H. Hubelhank
Connecticut Telephone and Electric Corp.

When designing or building a voltage-regulated power supply with a choke input filter, the average experimenter or ham usually casts a furtive eye at his "junk-box" when he reaches the stage for the selection of the proper choke. Usually he has a number of iron-core chokes that appear to be physically large enough to carry the current needed, but not enough data is known to identify them, in order to build a good ripple-free, voltage-regulated power supply.

As a result, unless the builder can identify the choke by manufacturer and part number, his only recourse is to go to a catalogue and buy a choke that will meet his requirements. However, by setting up a relatively simple circuit (see the schematic diagram) and following the procedures outlined, those "junk-box" chokes can be readily identified as to their electrical characteristics and, hence, can be salvaged.

To properly identify the electrical characteristics of an iron-core choke it is necessary that the basic characteristics of iron-core chokes and their effects upon power supplies be understood.

One of the most important characteristics needed to properly evaluate the suitability of a choke as an input filter for a voltage-regulated power supply is to know the relationship of inductance to the d.c. current flowing in the choke. This is important because as the d.c. current varies, so does the flux density of the core and, consequently, the inductance. This means that an iron core choke may have vastly different inductances under "load" and "no-load" conditions.

This characteristic may be utilized to good advantage in power supply filtering, because for most efficient filtering action the inductace should increase with a decrease in load current. It should be noted that a choke is called a swinging choke if the inductance is high at low values of direct current yet decreases markedly with increased direct currents. However, if the power supply has a bleeder resitor in parallel with the load, the importance of the ability of the choke to have its inductance increase with a decrease in load current diminishes, since there is always a minimum value of load current flowing through the choke.

At some point the choke will reach saturation as the current increases. This is due to the iron core becoming saturated, which decreases the permeability of the iron, and hence decreases the inductance of the choke. This, of course, determines the upper limit of usability of the choke under load conditions. In addition, it is important to know the maximum current the choke may carry without overheating.

It is also necessary to know the critical inductance of the choke, that minimum value of the input-choke inductance which prevents the d.c. output voltage from rising above the average of the rectified a.c. wave. This minimum value, the critical inductance, must be maintained at all currents, in order to prevent the filter from acting as a capacitor-input filter.

Therefore, it becomes evident that to properly use a "junk-box" choke it is necessary to have a plot of inductance *versus* load current. Then if the inductance range of the "junk-box" choke is proper for the design range of the filter needed, it may be readily used.

A relatively quick and comparatively simple procedure may be employed to plot this curve, using only a vacuum-tube voltmeter and an ammeter as test equipment. The test circuit should preferably be the full-wave rectifier of the power supply being built, with the choke and a high wattage rheostat in series across the output. (See schematic diagram).

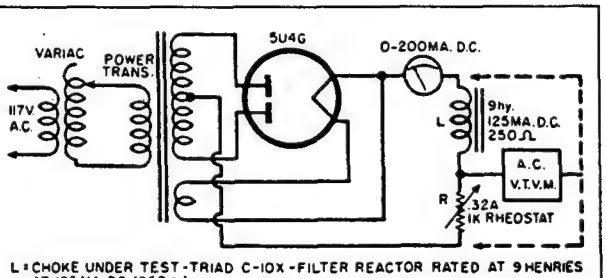
The test procedure is based on the following theory. An assumption is made that the d.c. resistance of the choke is small in comparison to its inductive reactance.

Hence, the normal equation for impedance: $Z = \sqrt{R^2 + X_L^2}$ becomes $Z = X_L$. The current flow through L and R is equal, consequently:

$$I = E/Z = E_L/X_L = E_R/R$$

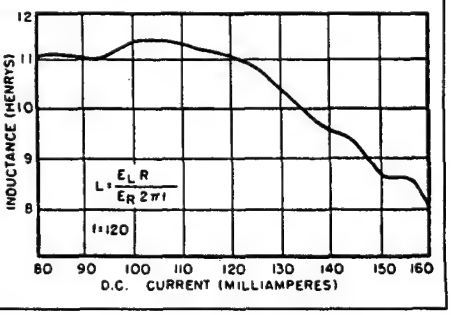
Solving for $X_L = E_L R/E_R = 2\pi fL$. Therefore $L = E_L R/E_R 2\pi f$.

Method for checking "junk-box" chokes as described in text.



L = CHOKE UNDER TEST - TRIAD C-10X - FILTER REACTOR RATED AT 9 HENRIES AT 125 MA. DC. (250Ω)
R = OHMITE RHEOSTAT - 1K .32 AMP.

CURRENT D.C. MA.	E_L (A.C.)	E_R (A.C.)	RES. OF R	CALCULATED INDUCTANCE OF L
79	50	4.5	750	11.
86	60	5.4	750	11.1
94	56	3.4	500	11.
100	62	3.6	500	11.5
125	49	1.5	250	10.9
136	58	2	250	9.7
144	48	.7	100	9.4
150	54	.84	100	8.6
155	58	.9	100	8.7
160	60	1.0	100	8.0



In actual use, vary the rheostat until the ammeter reads a low value of current. Measure the voltages across the rheostat and the choke with the vacuum-tube voltmeter, then measure the resistance of the rheostat. Substitute these values in the formula $L = E_L R / E_R 2\pi f$ and solve for L. The value of f in a full-wave rectifier circuit is 120.

Record this value of inductance and the current at which it was measured. Repeat this procedure until all the possible ranges of current that the power supply may require have been recorded.

When the curve has reached a point where the inductance starts to level as the current increases, the saturation point of the choke has been reached. Since this determines the upper limit of usability of the choke under load conditions, this is also the point at which the current rating of the choke should be checked. Leave the load connected for ten or fifteen minutes, carefully observing the case for signs of overheating. The choke may get warmer than body temperature, but should not burn the hand or get unduly hot. If the actual temperature of the choke is desired, fasten a thermometer to the case with putty. Be careful not to place the thermometer near the rectifier or any other heat producing tube. The temperature should be between 180° and 170° F.

The previously described plot will accurately show the point of saturation and how the inductance of the choke varies under different load conditions, and from this it can be readily determined if that "junk box" choke can be used in the power supply and whether it meet the design requirements.

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The Search for Musical Ecstasy
by Harvey "Gizmo" Rosenberg

RE: TECHNO-SHAMANS

Since the late Paleolithic period, in every culture, a special group of men — those endowed with both courage and gifts — have been responsible for exploring the outer limits of knowledge: ecstasy. We are the modern incarnation of these shamans, and like our ancient brothers we use our music to open the door to higher states of being. Some anthropologists would argue that solder flux is hallucinogenic, the soldering iron is a magic wand, and our single-ended triodes are totems — all used to release a primal instinct for musical ecstasy.

My fellow techno-shamans, now is the time to cast off the mealy minded robe of mediocre audio orthodoxy and explore an expanded gizmological metacontext for the electromechanical arts that create an ecstatic aural metaphor. . . with me.



In other words dudes, read my new 350 page richly illustrated book which will stiffen your resolve, conviction, and whatever else you use to explore the audio arts. It is $25, plus $4 shipping, $11 overseas airmail. Send checks, VISA, MC.

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Dear Friends:

During 1993 and 1994, my position as author and designer allowed me to travel and experience many exotic hi-fi systems in the States and abroad. As I traveled, I searched for persons with highly developed "internal references" for beauty and musical pleasure. These contacts taught me lessons about myself and the wide possibilities of the art of audio engineering.

I discovered that many music lovers have systems beyond what is available at *any* cost in normal high-end stores. These exceptional systems were always single-ended triode powered and they played ALL types of program with equal aplomb.

Every record, no matter how poorly recorded, was a joy and a revelation. Great performances which are unlistenable on most systems because of poor recording quality, became simply GREAT PERFORMANCES.

It wasn't that these components unnaturally embellished or beautified the recording. On the contrary, I never heard so much detail, texture and color provided for my listening pleasure, and I never heard hi-fi sound so right. I felt privileged to be listening to the music . . .like I was the first man on a new planet. I beheld what I was hearing with awe and amazement. There was a deep sea of information but it was human and completely unmechanical. When a system's tonal character is *truly* natural, the aesthetic worth of *all* recordings is elevated.

Believe me, this really happens — even on rip roaring rock and roll. I know this all sounds like hyperbole, but I am writing this letter to explain what I have heard, what is possible, and point out a rewarding approach to music reproduction in your home.

There are only a few systems of this quality in America, but there are hundreds in Europe and Asia. I don't know of any present-day US "high-end" manufacturer with the aesthetic sophistication, ethical values, or engineering open-mindedness to create this sort of *system*. I say *system* because it can't be done by six different component manufacturers. A system of the highest quality can only be made under a single, highly evolved, whole-system engineering aesthetic. Some of the great systems I heard were lovingly built by their owners. The rest were designed by Hiroyasu Kondo of Audio Note in Japan or the engineers at Audio Note UK.

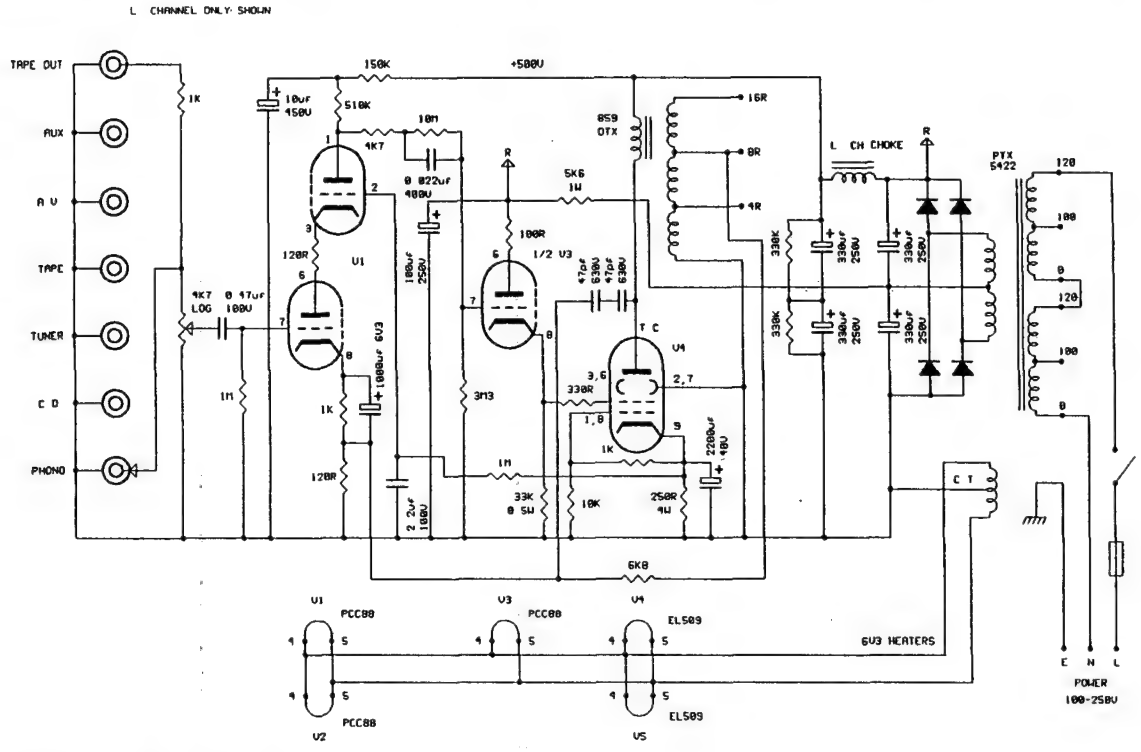
After I heard systems built around the *Ongaku*, the *Kassai*, the *Neiro*, and the *Meishu*, I began to wonder: "How many more years would it take me to design a complete system on this level?" I wasn't sure if I could build anything more than a copy, hopefully something almost as good.

The answer is: I have assembled a complete silver wired, Kondo-designed Audio Note system at the Staten Island Firehouse. My Bliss system is now all Audio Note. I would like to invite you to audition an audio *system* that will raise your internal reference for authentic musical reproduction.

AUDIO NOTE
new york city

Herb Reichert
718-876-9742
718-816-8598 fax

YOSHINO 859 ENHANCED TRIODE MODE SE AMPLIFIER



Tim de Paravicini on the 859:

I get fed up with having to defend my use of 519 type tubes, so I am not going to get into that discussion now.

The idea for the 859 stretches back a couple of years. I originally planned to launch it shortly after the Yoshino XXXA (single ended 845, £24,000) and Yoshino XXXB (single ended transistor, £20,000). I decided to see the reaction of the mainstream magazines before launching the more affordable 859 single ended amplifier. It became clear that no one was terribly interested in the B solid state version, the lighthouse 845 got all the attention. This despite the fact that the circuits are near identical, only the chassis layout is different. On the A. most of the heat is radiated by the tube directly into the air. The B had to have a massive heatsink as a chassis to sink the 100 watts of dissipation by the single transistor. The tube version is more expensive because of the very high B+ rail.

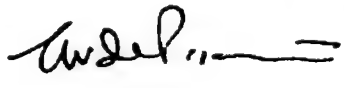
The output valve configuration of the 859 is somewhat unusual. The normal control grid is tied to the Kathode to make it an invisible element. The signal is fed into the screen grid. I call this Enhanced Triode Mode. I do not want to insult SP readers intelligence. I think they can work it out by themselves. Standard triode mode (with the screen grid strapped to the anode) was tried but did not give the same linearity of final solution. The design brief was 10 watts with minimal distortion. At 10 watts, THD is below 1% 20-20,000 Hz. Maximum output is 15 W, both channels driven. Bandwidth at low levels is 3-60,000 Hz.

It is not, and has never been my style to copy anyone else. I innovate, not copy. There was no way I was prepared to launch a 300B amplifier. Just about everything has been done with this tube. During my time with Lux, in Osaka in the mid-70's, I had first hand experience with original circuits and designs. That was then and this is now. To launch a 300B amplifier would be retrograde.

I do not deny the tube's strengths, but in current Chinese production (with one or two very expensive options) the quality is dire. They neither measure like an original Western Electric, nor sound like one. For the DIY enthusiast, it's OK. You can spend time sorting through the rot to find the good items. If the tube blows in a month's time, you can put it down to experience. If you're lucky, you may even find a brace of new old stock.

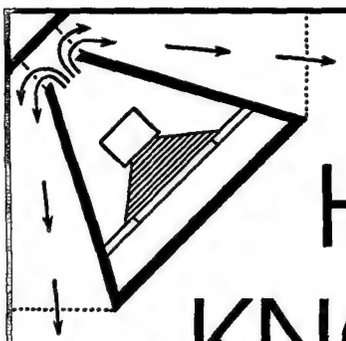
I have a reputation for bullet proof reliability and better than the rest build quality. If you drop an 859 on the floor, worry about the floorboards not the amplifier. I am not prepared to put my reputation on the line for designs that were second-hand knowledge in Japan 20 years ago, just because it is the current flavour of the month in the West. Most Japanese chose to build their own 300B amplifiers. Most sort parts from the Akihabra and build a complete custom amplifier. Even kit makers leave the final tube purchase to the customer.

The 859 is aimed squarely at those who enjoy good sound, reliability, build & looks. With its heavy chromed brass front panel, gold knobs, and near 20 kilo weight, I think it is a very good value product. The demand for it has taken by surprise. At this time (late December 1994), I have an 8 week waiting list!



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HOW TO KNOCK YOUR SOCKS OFF WITH 5 WATTS

Some general observations by The Baroda Bard and Ray

My friend Ray knows a lot about speakers. He designed them professionally for about 25 years and probably would do it again under the appropriate circumstances. The other day, I went over to Ray's house on the St. Joe River for lunch. After we chatted about close friends, poetry, pipe organs, music for same, fine food and wine, we talked about speaker efficiency, a favorite subject for both of us.

This article isn't about amps, at least not directly. The title screams that, I guess. But inherent in any discussion about single-ended triode amps, there is the nagging question of what speakers to use. What follows are notes that we put together as our discussion on speaker efficiency continued on for a few weeks.

Yes, I know there are some answers — ranging from classics like Western Electric and Altec "Voice of the Theatre" cinema sound systems, vintage home hi-fi systems, still available "vintage" designs like Klipsch La Scalas and K-horns, to contemporary "pro sound" gear, and home-brew designs of various sorts.

But how does one sort through this strange menu? How can you know which direction to go? While I'm convinced that the way to go is the speaker that "plays the most of your records" in an emotionally connecting way, I'm also inclined to get to this fine place via some grounded rationale. (Help, if you will).

Cut to the chase, you say. And don't bore or confuse me. OK! It's probably not far off to say that most contemporary "high-end" audio consumers are purchasing power amps ranging from 100 to 300 watts per channel. This is a difference in power that, all else being equal, produces a difference in sound pressure level (SPL) of 4.8 decibels (dB). 4.8 dB is a rather *modest* difference.

The above-described power range of 4.8 dB has sort of evolved to "work out" with a range in loudspeaker sensitivities (SPL developed with a 1-watt input at a distance of 1 meter) of something like 81 to 91 dB. This is a 10 dB difference, just over *twice* that of the power amps. A 10 dB difference in SPL is a difference of the genuine knocks-your-socks-off variety.

The 4.8 dB amp difference is able to deal with the 10 dB speaker difference due to variations in type of music listened to, the degree to which the listener wants to duplicate the SPLs of live music, the tolerance and closeness of the neighbors, size of pocketbook, size of room, etc.

Now, enter the single-ended triode amp! Not 100 watts! Not even 50 watts ('cept the Cary 805 monoblocks). More like 10 or 12 watts. Or the 2A3-powered AES SE-1 kit on my credit card—five (hot) watts. And me wanting to try that 2A3 amp I read about that does about 2.5 watts.

In short, with SE triodes on the scene, the contemporary status quo of speaker sensitivities no longer cuts it. Specifically, 2.5 watts is *16 dB down* from 100 watts, a LOT more than the 5 and 10 dB differences noted above. This article is about guidelines for building loudspeaker systems which can really knock your socks off with lower powered amplifiers by making up for the power shortfall with greater speaker efficiency.

The following comments are relatively brief and could build into several more detailed, longer articles—some more obvious than others. Making a speaker one of the ways described doesn't say it will necessarily sound good or be a perfect partner for your new flea-powered SE-triode amp, but the physical laws behind the examples might help select or design a speaker system that doesn't wimp out when powered the way you like it.

SPL Increase	Amp Power Increase	Subjective Reaction (You)
1 dB	1.3 times	Can just hear, if you're paying close attention.
3 dB	2.0 times	Pretty obvious, but not if the increase is at all gradual (not A-B).
6 dB	4.0 times	Can get your attention, even if you're not listening for it.
10 dB	10 times	Knocks your socks off. Twice as loud.

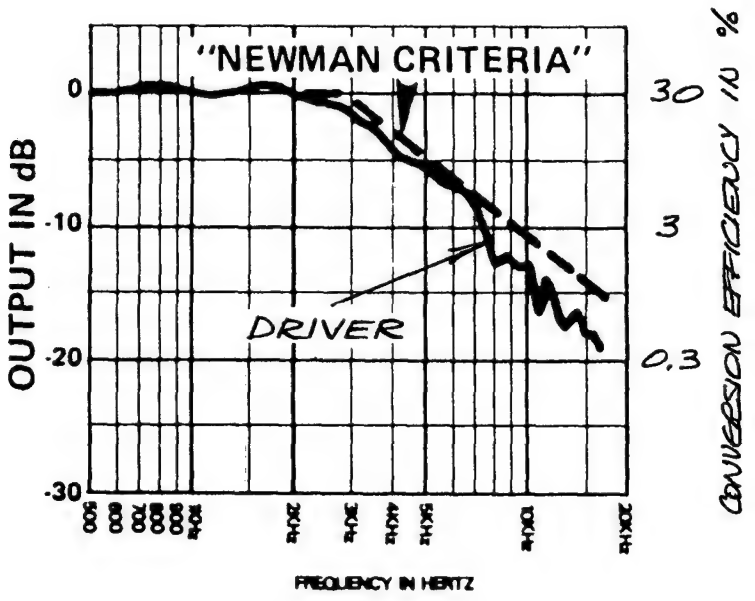


Figure 1—The "Newman Criteria" for Compression Drivers Compared to a Typical High-Quality Example (basically no exceptions)

High-Frequency Compression Drivers

Compression drivers can theoretically be about 50 percent efficient, that is, convert 50 percent of the electrical power input into the acoustic power we hear.

Physical realities, like air squeezing through small slots and friction in diaphragm suspensions, conspire against this happy result, to produce a real-world maximum of around 30 percent. (This is just over 2 dB down from the 50-percent maximum.) And that maximum only holds up to about 3 kHz, beyond which additional gremlins produce a treble roll-off of about 6 dB per octave. That means that at 6 kHz the efficiency drops to 7.5 percent. At 12 kHz, efficiency is just under 2 percent! And this is for a very well designed driver.

Around the world, I've spoken about this more-or-less ignored (except to those who make a living designing compression drivers) characteristic, and dubbed it the "Newman Criteria," after my friend Ray, who first explained it to me over 20 years ago. The Newman Criteria and the performance of a typical high-quality compression driver are illustrated in Figure 1.

The reality of the Newman Criteria means that if you just slap a good compression driver on a horn and sit back to listen, it's going to, by definition, sound dull, unless:

1. The designer has depressed its midband efficiency to produce a sound with "more highs." Or—

2. The driver has been placed on a horn whose coverage angle decreases with frequency in a way that compensates (or partially compensates) for the driver's inherent high-frequency roll-off. Straightforward exponential horns and the closely related radial horns (e.g., Altec 511B and 311-90) display this characteristic. It amounts to a sort of "acoustic equalization" that applies only to the guy listening on the horn axis. Off-axis listeners will end up being short changed.

In my experience, the most respected "professional" compression drivers hew close to the Newman Criteria: Altec 288, TAD 4001, JBL 375, 2441, 2445, 2446, and EV DH1 and DH1A. I suspect it also applies to the Western Electric originals. But many drivers don't come close. Meeting the criteria is expensive.

And the criteria also applies to tweeters, e.g., JBL "bullets" or the EV ST350, except that they join the Newman Criteria on its downward slope above 3 kHz, since their diaphragms and horns are too small to go down in frequency to the 30-percent efficiency range.

What About Woofers?

Ray says that horn-loaded woofers never seem to quite reach the 30-percent figure, for reasons he has never seen explained, topping out at about 20 percent. That's about 2 dB down from 30 percent. Horn-vented "combination" low ends such as the Altec Voice of the Theatre approach the 20-percent figure only in the upper octave or so of their overall operating range (about 50 to 500 Hz), because their relatively small, straight horns are insufficiently large to act as horns in the lower octaves—they turn into vented direct radiators in this range (see next paragraph).

Very-high-efficiency direct-radiator woofers are about 5-percent efficient in an acoustic half-space (where the output is restricted by a large baffle to one-half of a sphere). These speakers pack all or most of the voice coil in the gap, and include 1950's JBL, Altec, Stephens and EV hi-fi designs, among others; and whose currently available descendants are still used by guitar players, (e.g., EV EVMs and the JBL E series). 5-percent efficiency is down almost 8 dB from the compression driver's 30 percent!

And if - 3dB low-frequency limits in the 32- to 40-Hz range are sought, efficiency offerings in the 2- to 3-percent range result in enclosures much less like refrigerators. I like the 32 Hz, which Ray once described to me as a "magic" number because it encompasses a 16-foot, 32 Hz organ stop.

Picking the 2.5-percent middle of the range, that's nearly 11 dB down from the 30-percent-efficient compression driver! And for those of us who remember when Ed Villchur (Acoustic Research) invented the acoustic suspension bookshelf speaker system, c.1956: its half-space efficiency was about 0.5 percent, nearly 18 dB below all those WE compression drivers that first appeared in movie theaters. If 5 watts works for a good ol' WE driver, digging up 18 dB of efficiency reduction jumps the power requirement to over 300 watts. Ouch!

Table 1 summarizes these efficiencies, the related 1W@1m sensitivities, dB SPL losses that result as efficiency is reduced from the 30 percent top, amp power implications, and the net internal box volume required to realize low-frequency 3-dB-down points (f_3's) of 40 Hz. (Double all the box volumes for 32-Hz f_3's).

I added one particularly interesting system type to the chart, the multiple direct radiator. Up to the 300 to 500 Hz range, using multiple drivers increases efficiency, and four direct radiators essentially match the efficiency of a fully horn-loaded device—with a box one-half to one-quarter the size. Think about that!

RAY'S DISCUSSION of TABLE I

In the table, a number of low-frequency systems with varying efficiencies are noted with dB SPL losses that result as efficiency is reduced from the 30-percent top limit. Also noted are the internal box volumes required when a - 3 dB low-frequency limit of 40 Hz is desired. The various systems shown are nearly optimum designs for the efficiency levels shown.

Several interesting things are revealed by the table:

1. Relatively high efficiencies (5 percent and above) imply relatively large boxes, less deep bass, or both.

2. As efficiency requirements are lowered, box volume reduces proportionately for a fixed low-frequency limit (40 Hz here).

3. Multiple direct radiators can compete with bass-horn efficiency and have smaller boxes.

   [Not in the chart but note: reducing the acoustic environment from the specified half space to that of a corner, an acoustic eighth space, changes the game enough to, for example, reduce the horn volume by roughly a *factor of four*, to 20 ft^3! Paul Klipsch's classic corner horn is one approximate example.]

4. While loudspeaker "sensitivity" and "efficiency" are often spoken of as the same thing (which does well enough for the rough approximation), these are two different concepts related by the directional properties of the loudspeaker.

   For example, while 10 and 15 inch loudspeakers may radiate the same amount of acoustic power from a given electrical power input (and thus have the same *efficiency*, i.e. output power divided by input power and expressed as a percentage), the larger

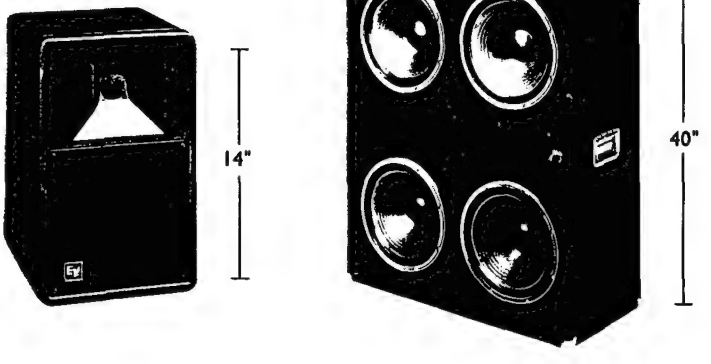
Table I —Fundamental Efficiency, Sensitivity, Amp-Power and Size Facts for Selected Low-Frequency Loudspeaker System Types with Low-Frequency 3-dB-Down Points of 40 Hz

System Type	Half-Space Conversion Efficiency	dB Down from Compression Driver Efficiency of 30%[1]	Factor of Amplifier Power Increase to Make Up for the Difference	Probable Sensitivity (1 W/1 m)[2]	Net Internal Box Volume[3]
Fully horn loaded (mouth large enough for a half-space environment)	15-20%	1.8-3 dB	2.0-3.1 times	108 dB[4]	80 ft^3
High-efficiency direct radiator (single woofer)	5%	8 dB	6.3 times	99 dB	7.2 ft^3
Medium-high-efficiency direct radiator (single woofer)	2.5%	11 dB	13 times	96 dB	3.6 ft^3
Low-efficiency direct radiator (single woofer)	0.5%	18 dB	63 times	88 dB[5]	0.72 ft^3
Multiple high-efficiency direct radiators (four woofers)	18%	2 dB	1.6 times	107 dB	26 ft^3

1. 10 $\log_{10}$ (efficiency X%/30%) rounded to the nearest dB.
2. 100-800 Hz. The horn and multiple-direct-radiator sensitivities are from commercial examples available in the last decade. The high-efficiency direct radiator example is actual performance of a 15-inch system currently available. The other direct-radiator examples are calculated from the efficiency differences relative to the 5% direct radiator. For the direct radiators, actual results could vary slightly due to directivity differences. Also, the horn is more sensitive relative to the 5% direct radiator (108 dB - 99 dB = 9 dB) than the efficiency difference alone would indicate (10$\log_{10}$ (5%/20%) = 6 dB) because the radiating area of the horn mouth is significantly larger than that of even a 15-inch cone.
3. Direct radiators are in vented enclosures producing "maximally flat" response.
4. 20 percent efficient.
5. Not by any means the lowest sensitivity rating typically encountered for high-end loudspeaker systems.

Four high-efficiency direct radiators can provide the efficiency of a horn — 19 dB more sensitive than a typical small monitor.

That difference would turn five SE watts into 397 watts!



loudspeaker has a narrower coverage angle above the low-bass range and will therefore have a higher *sensitivity* —producing a higher on-axis SPL at mid and high frequencies for a given power input. This is because squeezing the same amount of acoustic power into a smaller angular zone results in higher sound pressure on axis. This concept is intuitive, I think.

System Interrelationship Equation

The points illustrated by the table are not arbitrary. They follow a scheme that is dictated by something we have come to call the "system interrelationship equation." This equation allows you to interrelate certain important performance and size matters to the hardware required in pulling it off. This equation is:

$$E = CV(f_3)^3K$$

where "E" is efficiency, "C" is a constant fixed by the environment being radiated into and the numerical system being used, "V" is the box's internal volume, "f_3" is the low-frequency 3-dB-down point (notice that it is *cubed* in the equation) and "K" is another constant, the system constant, related to the type of system you have (sealed, vented, horn, etc.).

As you might expect, the loudspeaker itself (unmounted) needs to be appropriately designed for the equation to hold true. Two good-guys named Thiele and Small go into this in detail—I will try to avoid that but bear with me because the equation is a neat piece of mathematics.

This equation holds for the low- to mid-frequency range, from whatever you're willing to settle for at low frequencies to something like 500 Hz (give or take an octave). It's also what's called a "small-signal" equation so it doesn't tell you much about cone excursion.

The system constant, K, typically varies from something like 0.5 to 4 in a certain measurement system. Well-designed sealed systems can approach a K value of 2, vented systems can approach 4 and very good horns appear to be between 1 and 2 although the results aren't completely in on them.

And now, my final (gasp) remarks:

1. Because f_3 is *cubed*, the thing can really turn on you when you want more bass. One more octave down (i.e., one-half) means one-eighth the efficiency (a 9 dB loss). To hold the same efficiency, *eight times* the box volume is required.

2. When you shrink box volume something has to give (efficiency or f_3) unless you can up K somehow.

3. A larger K helps everywhere and (with certain restrictions) can allow direct radiators to have very high efficiencies in smaller boxes (or lower f_3's) than horns.

4. The constant "C" gets larger as you restrict the angular zone radiated into at low frequencies. Corners, an acoustic eighth space (as noted earlier), are most helpful (but often not the most available) and hanging in space (an acoustic whole space) the least.

The really great thing about the system interrelationship equation is that it reveals a lot about what you can and can't do. Here's to the Bard's 2A3 five watts!



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TRIODE AMPS AND SPEAKERS

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Development of a 211 Amplifier

Part 3: Reducing Diode Noise

John Camille, Chimera Labs

OVERVIEW

Much has been written these past few years about the deleterious effects of solid state rectification in audio amplifiers. Excellent treatises on the cause of these effects have appeared in TAA, GA, and other audio periodicals.

This article will provide the experimenter with a few techniques to cure or reduce the problem in existing equipment. New equipment can be built with better than 100 dBV reduction in diode noise when the techniques outlined in this article are used together with the techniques outlined in my previous article on the 211 power supply.

Done properly, silicon diode supplies can be built that are quieter than untreated vacuum diode designs. One must remember that vacuum diodes also generate a significant amount of white noise that should be corralled in better designs.

Noise reduction for either vacuum or silicon diode rectifiers is a worthwhile undertaking. When silicon diode noise is controlled, the reliability factor and the virtually limitless lifespan of solid state diodes in properly designed supplies points toward the choice of silicon rectifier devices over vacuum tubes.

DIODE NOISE

The primary culprit responsible for the noise generated by good quality silicon junction diodes is the turn-off characteristic. A reverse pulse is generated by the minority carriers crossing the junction after the majority carriers have galloped through. Tremendous strides have been made recently in reducing this effect in diodes designed for use in switched mode power supplies (SMPS). The processes used to create these fast turn-off devices avoid many of the noise and oscillation problems of older diodes. However, reverse recovery pulses still exist. The energy distribution as a function of time varies with each device but the general trend is down at a rapid rate, as semiconductor designers seek to meet requirements for more efficient SMPS designs.

I have been doing empirical work with the simple-minded idea that the very fast fall time pulse excites the LC resonant circuit presented by the secondary winding of the transformer. The excitation of the LC circuit produces a damped wave burst of RF energy centered on the resonant frequency of the transformer. I have measured the burst frequency fundamental on different transformers at frequencies between 6 kHz and 165 kHz. Of course, the oscillation frequency (f_0) is transformer and installation specific.

What all this means to the experimenter is that there are one or more transmitters buried in your amplifier. These transmitters produce 120 harmonically-rich pulses each second with a fundamental frequency (f_0) for each diode rectified supply. These pulses are radiated and conducted to other parts of the amplifier where they are detected and amplified along with the desired signal. Those beautiful wiring harnesses of old are real sonic killers for this reason. What you get is "diode grunge" that rides on the audio signal.

A more insidious problem is that these diode created bursts are also coupled back into the AC mains where they can affect unprotected low level stages elsewhere in the system.

My first practical experience with this phenomenon occurred a while back when overhauling a 6 1/2 digit DVM. A periodic toggling of the last two digits was eventually traced to a 50 kHz damped wave burst at a 120 Hz rate that beat with a 50 kHz clock causing the false toggle. This few hundred millivolt burst rode through the 17 V regulator into a second regulator that provided a 7 V reference for the ADC.

After trying the usual bypass and filtering cures to get rid of the pesky wiggle on the scope trace, the eventual cure was very simple in retrospect. I replaced the two 3A diodes for the 5V power supply with Schottky diodes. The original pn diodes ran too hot and their silver plating was whispering. "Son-of-a-gun!" . . . the pesky burst disappeared from all the supplies as soon as I put the Schottkys in.

Afterwards, I rationalized the cure, thinking that Schottky diodes have relatively few minority carriers, thus they provide little kick to the LC resonant circuit formed by the secondary winding. Since then, I have routinely replaced all of the pn diodes with Schottky diodes when I rebuild and recalibrate instruments for my shop.

I discovered the same pn burst problem during early work on the 211 amplifier. The attitude at the time was, "If I could see an artifact on the scope, it would be audible". In went the Schottkys on all low voltage and bias supplies. The high voltage supply for the 211 was another problem, however. A suitable bridge for the 1400 V power supply would require around a hundred 90V devices in the stack! Enter brute force techniques . . .

RESONANT FILTERS

The resonant frequency of the plate transformer secondary was measured and parallel resonant RLC filters were added between the winding and the HV pn diode Stack. This expedient reduced the pn burst from several Volts p-p to 50 mV p-p. A series resonant filter added between the bridge output and ground reduced the burst to a few mV. A low-pass pi filter with a cut-off frequency around 400 Hz was installed between the diode bridge and the first filter capacitor. Afterwards, the burst was no longer visible on the 100 uV position of the scope!

The resulting suppression circuitry is shown in Fig 1. Parallel resonant RLC circuits Z1 and Z2 are high impedance traps that dissipate 26 kHz energy in the parallel resistor. The inductance (L) and capacity (C) of this circuit is determined from the formula:

$$LC = \frac{2.533X10^{10}}{f^2}$$

where: f = frequency (kHz)
L = inductance (uH)
C = capacitance (pF)

So, if f= 26 kHz, then, LC= 9.7423 X 10^5
select L= 470 uH, then C= 2073 pF
use 2200 pF (Mallory CK05 Bx222K)

The value of R1 is determined experimentally. A good starting point is to make R1 equal to the DC resistance of the transformer secondary. R1 should be a 0.5W carbon or metal film. Do not use wirewound resistors unless they are wound to provide the appropriate inductance (L). Many small chokes have appreciable DC resistance which can alleviate the need for an outboard R1.

The current rating of L should be 2 to 4 times the DC current rating of the supply. The capacitor for this network should be a CK05 or CK06 ceramic unit rated at 100 or 200 V.

LC values for the series resonant RLC circuit Z3 are determined with Formula 1. The current rating for L needs to be only a few mA. The voltage rating of C must safely exceed the peak value of the rectifier output. A 3 KV ceramic would work well here. The value of R2 again can be determined empirically. Try the supply load resistance for starters, calculated as DC output voltage divided by DC output current.

A resistance value somewhere between the load resistance and a short (zero ohms) will usually provide the best null for the burst. Use a binary hack technique to determine the null, i.e. parallel a 24K, then a 12K, then a 6K, and so on. The null is very broad (or possibly nonexistent in some cases), so don't expect miracles.

The low pass filter Z4 should be sized to provide as low a cutoff frequency as available parts allow. The idea is to have the burst frequency as far down the attenuation slope as possible. Those that have modern network-theory design computer programs can implement a low pass response with a notch at the burst frequency. For us slide-rule guys, an m-derived π section out of your favorite text should work well. I usually employ the TLAR (that looks about right) principle along with my reactance slide rule when selecting parts for my first gouge at this type of filter. The input and

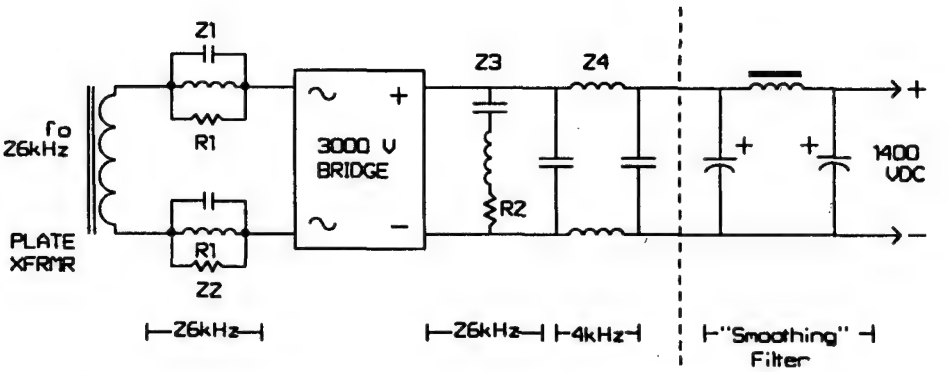


Figure 1: Primary Components of Diode Suppression Network

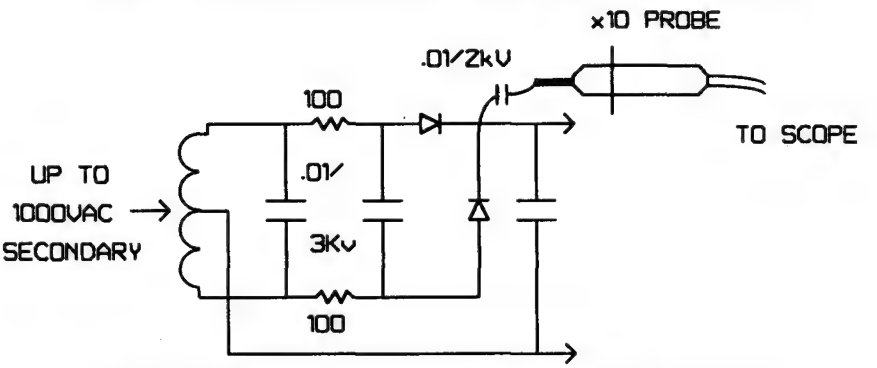


Figure 2: RC transient suppression and pn burst observation

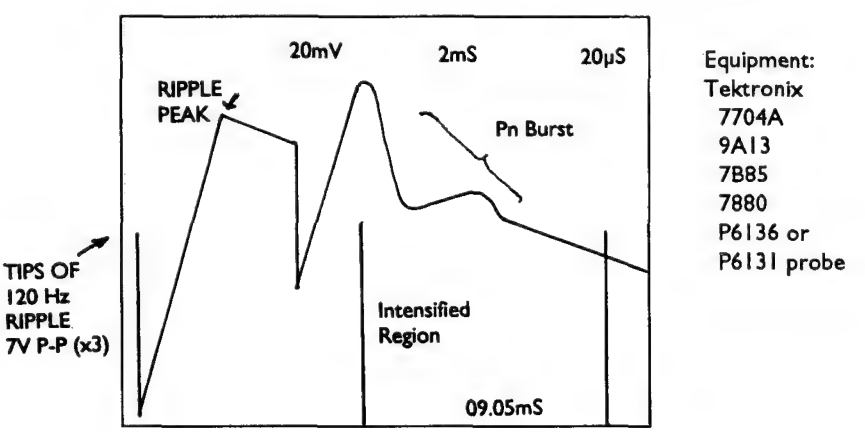


Figure 3: Depiction of scope display of the pn burst

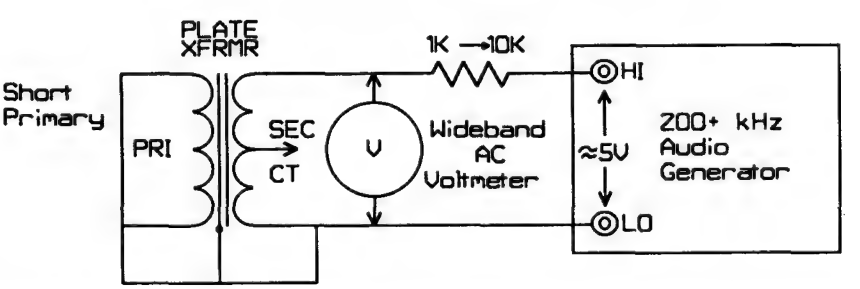


Figure 4: Test setup to measure HV secondary winding resonant frequency

output impedances vary wildly and are virtually impossible to model. When finesse is too difficult, use a bigger hammer!

RC FILTERS

Simple RC filters can be used on low current supplies for voltage amplifier and driver stages. Several 100 ohm resistors and two .01/3 KV capacitors are all that have been necessary for complete elimination of pn burst in a number of systems. See Figure 2. The resistors added in this location can also be increased as necessary to bring B+ values down to the original value when replacing vacuum diodes with pn diodes. Dale type RH and RS style power resistors work well here even though they are wire wound.

LOCATING pn BURST NOISE

A sensitive oscilloscope with a dual or delaying time base is necessary to observe pn burst effects. Connect the scope test probe to the rectifier output as suggested in Figure 2. Increase the sensitivity on the vertical channel while varying DC offset to keep the positive peaks of the ripple on the screen. Engage the delayed sweep and scan the area behind a ripple peak with the DELAY TIME control, see Figure 3. *Caution:* use a .01/2KV capacitor in series with a conventional probe when working with HV supplies.

DETERMINING f_0

The resonant frequency of a transformer installation can be measured directly from the display shown in Fig. 3. This method may be more accurate since it takes into account installation effects. However accurate sweep measurements require more elaborate scope facilities than your average audiophile might possess. The RLC networks described above have very broad characteristics which allow for considerable error in measurement anyway.

The setup shown in Figure 4 may be used to measure the "dry" resonant frequency of the transformer. This frequency measurement will probably be well within the bandwidth of the RLC traps described above. The audio oscillator and the high impedance AC voltmeter should be capable of operation to at least 200 kHz. The value of the source resistor is not critical. Use the highest value that gives a usable reading on the meter. Higher value resistors will give a sharper peak in the measured response.

To measure the resonant frequency: slowly sweep the oscillator over the 1 kHz to 200 kHz frequency range. A number of small peaks and valleys will usually be observed along with a single prominent peak at the fundamental resonant frequency of the secondary. This peak can reach several times the input voltage on very high quality transformers. Traps are cut for the frequency where the peak occurs.

CONCLUSION

The noise suppression technique described above will remove several layers of grunge from the sound of an amplifier. One or more sets of traps may be necessary to remove this noise. The process is strictly empirical at my level of understanding.

Some rules of thumb are:

Better transformers (C cores and toroids) may require a combination of the parallel, series, and pi filters for best results. Older transformers with poor insulation and high secondary resistance may require only the simple RC filter.

Very high-speed diodes are harder to tame. A high-speed, 1 or 2 nS rise time scope will show the initial spike, though greatly suppressed when using LCR traps. I use the 4 uS ERCOL-15 "Collmer" rectifier from Allied. This diode, although relatively slow, has clean noise characteristics and does not oscillate in the knee of the transfer curve. The parallel resonant traps between the diode stack and the transformer is usually adequate treatment for this diode.

The transformer-rectifier-filter interface must be *short and sweet!* I am wary of leads (antennas) over one inch long. My "new construction" supplies are fully shielded per a future article in SP. VHF RF construction techniques will make even the quietest amplifier quieter and sweeter! If you must bundle wires, use triaxial coax with proper grounding techniques. Think RF!

In closing, thanks for the many comments on the first two articles of this series. The comments and computer analysis of Bill Petrowsky have been especially helpful and much appreciated.

REFERENCES

Marovich, Scott. "Snubber Strategy" in Letters to the Editor, *Audio Amateur* 3/94

Miller, Rick. "Measured RFI Differences between Rectifier Diodes in Simple Capacitor Input Power Supplies," *Audio Amateur* 1/94

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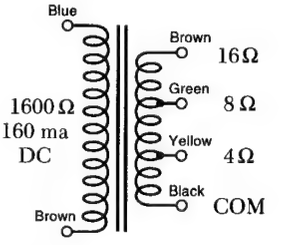
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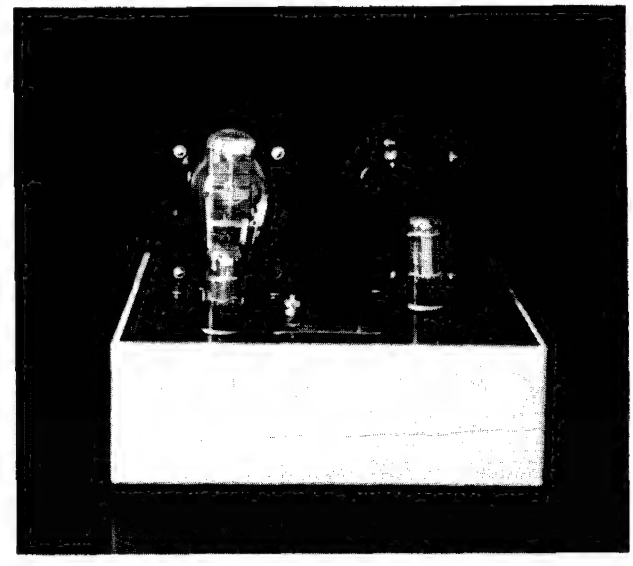
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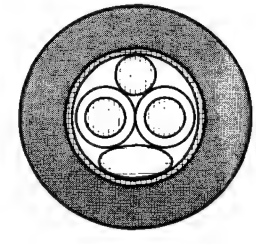
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Delusions of Manhood

I was interested to read Seth Goldwin's review of the Audio Electronic Supply SE-1 in the Vol. 2, no. 2 issue of *Sound Practices* but was puzzled by one of his observations. On page 7 Mr. Goldwin states, "Successfully building your own gear is the kind of thing that makes you proud to be a MAN, if you know what I mean." Hmmm. I just finished building an Audax of America A652 speaker kit, but I never noticed delusions of manhood setting in. I must not have been paying attention.

Nancy MacArthur
White Rock, NM

Tweek of the Week

I wanted to throw in my two-cents worth regarding the Audio Electronics Supply SE-1 amp. I have built two of them to bi-amp a pair of homebuilt speakers (Aria 5-types using Cabasse drivers and external crossovers achieving 92 spl sensitivity). One amp powers the mid-bass drivers with 300Bs off the 4 ohm taps. The other amp powers the tweeters using 2A3s off the 8 ohm taps. I am extremely happy with the system, but this wasn't always so.

When I built and ran the first amp, I had the same impressions Seth Goldwin described in his review. The sound was pretty good but was afflicted with dynamic compression, slightly soft transients, and lack of high and low extension. The amp seemed to be missing important spatial information, presenting a rather small, flat, and glassy smooth image. Given the good quality transformers and basic circuit layout, I knew this amp could do better.

I initially used Vitamin-Qs for coupling because I prefer the slightly dark, rich sound they provide (I prefer espresso to Columbian for similar reasons). I replaced them with Hovlands and indeed got better transient response and more light on individual instruments. However, soundstage width and depth were still undersized and dynamics had not improved. I then looked at the power supply stage as a possible culprit. In reviewing the schematic, I noted a 20 ohm resistor between the two 560mf electrolytic caps in the pi filter. I replaced the resistor with a 2.5 henry, 300 mA choke, which I was able to mount on top of the chassis between the left 6SL7 tube and 560mf cap. The improvement was remarkable. The soundstage grew five feet in every direction and instrument placement was much more 3-D.

After this very pleasant surprise wore off, I became unpleasantly aware of grit in the upper frequencies, which I attributed to the heavy-handed use of electrolytics throughout the power supply stage. I downsized both 560mf electrolytics with 230mf electrolytics. I also removed the two 47 mf caps on the 6SL7 power supply. Using a bunch of 12mf, 1000V canister-type oil caps I acquired from an electronics surplus store at $2 apiece, I made four cap banks of four caps each. I wired a bank to each of the vacant 47mf positions, and bypassed the 230mf caps with a cap bank. As a result, the highs have acquired a wonderful satin sheen. Massed violins were especially pleasant to listen to. The amp's dynamics, speed, and rhythm greatly improved. I did not notice an increased noise floor or loss of resolution; on the contrary, high frequency resolution improved.

I should note that my power line is heavily filtered via an 8.5 constant voltage transformer cascading to an 8 amp isolation transformer. I have found that such filtering produces at least a 20% improvement in the sound of triode amps.

Given the upgrades to the power supply, I went back to my Vitamin-Qs and was able to fully appreciate their special beauty. The moral of the story is: don't blame the coupling caps for everything — the power supply is equally important in single-ended circuits.

I am now extremely happy with my SE-1 amps. Given their low initial cost and ease of modification, I can strongly recommend them. In tandem, the amps deliver the bass punch and headroom necessary to drive a wide array of speakers, not just ultra-sensitive horns. Where else can you get this much world-class triode power for less than $1800 (or $1300 if you use Chinese tubes!)?

Michael Pashall
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Department of Corrections Issue #6

Morrison 71A line stage/xover
p. 14 — 90 V should have been penciled in *at the plate* of the 71A rather than on the supply side of the plate resistor. Supply voltage is approx. 220V

Vans Evers Chorus
p. 50 — R101, mysteriously absent from the component list, is a 2K unit. The unlabeled resistor located next to it in the power supply is 100 ohms.

Camille Shunt Regulator
p. 44 — the unlabeled resistor between the 4K32 and the 49R9 is a 1K unit.

ATARASHI-SAN

Just a note to tell you what I suspect Alan Douglas has already. In *Sound Practices* Summer 1994 (Vol. 2:#2), Orfeo 211 A, pg. 19, the authors refer to a 1971 Atarashi circuit. In Japanese, the word "atarashi" means "new". I don't think this word is a proper name in Japanese as used in the article.

I have also asked several of my Japanese friends and none have ever heard of anyone named Atarashi. Just thought I should write and let you know. Keep up the good work.

Charles M. Wilson
Burnsville, MN

I have received *SP* issue 6, so my last week-end was saved. Let me go into details regarding the ATARASHI circuit (p.19). The published schematic is not the original circuit, but a circuit revisited by Jean Hiraga to adapt an EL34 driver tube instead of the scarce Japanese 6GA4.

Note that some French audiophiles use that circuit with WE300B in the driver stage, and vapor mercury rectifiers in the B+ power supply.

Marc Veyer
Lille, France

ed— Yes, Virginia, there is an Atarashi. He worked for Denon and Phillips Nippon, according to Jean Hiraga's book. More on Atarashi-san and big triodes next issue.

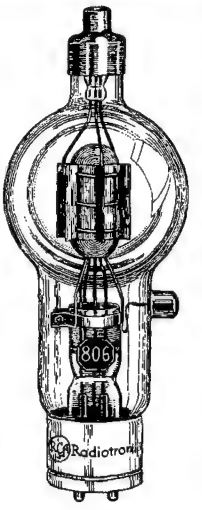
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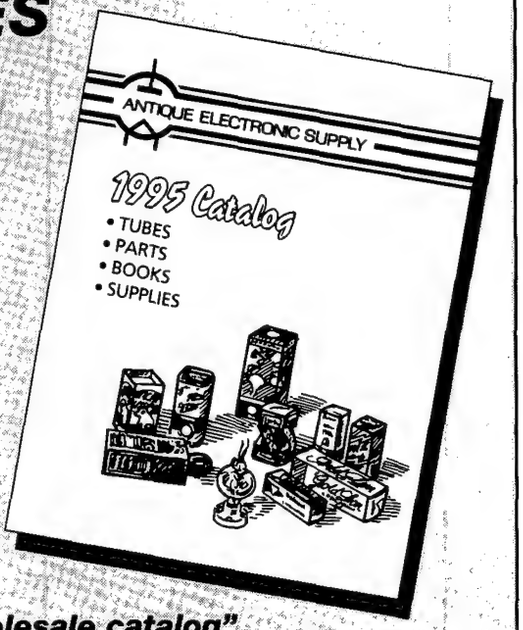
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units unless bias voltages adjusted. They work fine in most everything else.
KT88 National-USA Not cheap but if you want sound and quality similar to old Genelex ande can't find 'em it's the next best thing. Call us for current discount price.
6CA7/EL34 EL34-G Russia Narrow bulb- sim to Siemens 14.95 matched pair
6CA7/EL34 Russia fat bulb (Looks like GE) 21.95/match pair
6CA7/EL34 Tesla, looks just like E34L but base color is different. 19.95/ matched pair
Dynaco ST70/MK4 should use EL34-G or Tesla Mark II can use all 3 types.
With our boards we suggest large bulb Russian 6CA7.
6L6-GC..Russia 6L6WGC/5881 15.90/mpair Russia 6L6-GC 11.90/mpair GE(USA) Call
6V6-GT Russia 3.95 each Brimar (England) 6V6-GT/CV511 9.95 each
5AR4/GZ34 Russia (new improved type) 8.95
300B China (new brown base type) 74.95 each **300B Cetron** USA made 179.00 each
Russian Tubes 5U4-G 5.95 6AS7-G 7.95 6BQ5/EL84 3.95 6C33 29.95 6EU7 9.95
6N7-GT 3.95 6SJ7 3.95 6SL7-GT 3.95 6SN7-GT 3.95 811A 12.95 6267/EF86 4.95
7189/EL84-M 5.95 7199 8.95 **Chinese Tubes** 2A3 15.95 211 26.95 845 26.95
Other popular tubes Lots more not listed, please call!! (call for info on current stock)
5U4-GB 12.95 6AN8 5.95 6B4-G,6A3, and 6A5-G..use 2A3. These are all identical except for filament and basing. (The Chinese ones work fine in lieu of US made if you can't find any!)
6BM8/ECL82 3.95 6C4 4.95 6CA4/EZ81 4.95 6CW4 8.95 6DL4/EC88 4.95 6FQ7 USA..Call
6GK5 USA 5.95 6GW8/ECL86 3.95 6J7 3.95 6SC7 6.95 6V4 3.95 6X4 3.95 7F8..see
2C51/5670 (electrical equivalent) 12BH7 9.95 12BY7 9.95 12X4 3.95 5751 Call 5879 7.95
5965 5.95 7247/12DW7 14.95 DG7-32 59.95
SORRY! We do NOT have Amperex or Telefunken tubes in most of the popular numbers!
TUBE SALE Prices and quantities on following items are limited to stock ON HAND, and all sales FINAL (that's why they're cheap!)If you need more info please ask first.
All are unused and most in original cartons. 6AK5/EF95/5654 1.50 6AK6 75¢ 6AL5/5726 95¢
6AT8 1.50 6AU8 1.00 6AU5-GT 1.50 6AX4-GTA 1.50 6BK5 50¢ 6BN6/6KS6 1.95
6BQ7/6BZ7 1.95 6CB6 1.50 6DG6 1.95 6DT6A 50¢ 6EH7/EF183 75¢ 6EW6 1.50
6GK5 Japan 1.50 6GF7 1.95 6GS7 50¢ 6HA5/EC900 95¢ 6JB5/6JC5 95¢ 12AL5 25¢
403B/5591 1.95 407A 1.00 408A 1.00 5670/2C51W 1.95 5920/E90CC 1.50 6689/E83F 3.95
7721 4.95 7722/E280F 4.95 7734/6GE8 9.95
Limited Quantities on following Philips/Sylvania Tubes 6188/6SL7-WGT (almost-a-5691) 5.95 **12FQ7** (Italy) 6.95 **40KG6/PL509/PL519** (USA) 7.95 **6GH8** (USA) 2.95 **7895** 9.95
Tube Manuals RCA 1959 reprint (RC-19)10.95 **Western Electric** Reprint 15.95
RCA Transmitting Tube manual, (TT-5), covers 811A, etc. reprint 12.95
OEM Spec sheets (usually 4-8 pgs, with curves, etc.) for most tubes available, $2.00 per tube

Replacement PC boards for Dyna ST70, Mark 3

Ideal for those who wish to experiment as well as upgrade..unrivalled versatility as well as good fundamental design and reasonable price. Better performance than boards using 6GH8, reliable, easy to install and modify.
Too much to explain here...Ask for our flyer for more details.
Note: Board prices do not include tubes.Construction requires a good volt/ohmmeter, simple hand tools, good basic knowledge of electronic principles and components.
ST70 requires 1-12AX7, 2-12AU7, Mk3 requires 2 12AU7 per board (4 for 2 amps)
PC Board Blank 29.95 (ST70) 49.95 per pair (MKIII)
PC Board with Parts 44.95 (ST70) 69.95 per pair (MKIII)
PC Board assembled ready to install 69.95 (ST70) 99.95 per pair (MkIII)
All above include our comprehensive manual.



Hard to find NOS tubes. We reserve the right to limit quantities. Tubes are unused, vintage stock. Most have original boxes, some are OEM stock or had damaged boxes and were boxed by us. We guarantee for 30 days, occasional cosmetic defects not included.
Where no mfr listed we have several brands on hand, please call for details.
5Y3-GT RCA, GE or Sylv 2.95 5V4-GA Sylvania 4.95 6C5 GE 3.95 6C6 2.95 6D6 2.95 6F5 2.95
6EU7 RCA 9.95 6FQ7/6CG7 RCA clear top 14.95 6FQ7/6CG7 Sylvania,RCA or GE 11.95
6N7 metal USA 5.95 6SF5 2.95 6SJ7 metal USA 5.95 6SL7-GT GE, Sylvania 5.95
6SN7-GTB Sylvania 7.95 12AY7 RCA, GE, Sylvania 7.95 12AX7A/7025 Tungsol 14.95
12AX7A OEM labelled "Webcor" (actually GE mfr) 9.95 12SJ7-GT 2.95 12SL7-GT 2.95
12SN7-GT 2.95 '56 4.95 '75 7.95 76 RCA, JAN Nat'l Union 5.95 '80 4.95 864 9.95
5879 RCA, GE ,Sylvania 7.95 6005/6AQ5W 1.95 6072 RCA 11.95 8172/4X150G Eimac 19.95

Specials..limited quantities!Ask for complete clearance flyer.
Oil Cap 17 + 4 uF 440VAC, tested,clean, used 4.95
Computer grade capacitors! 1900 uF 250V Mallory 4.95 580 uF 400V Mallory 4.95 1100 uF 450V Sprague 9.95 270 uF 350V 3.95 (Clamps-1.50)
Capacitors, These are 1 3/8"dia: **32-32-16-16 at 450V** 6.95
1" dia mount on sideways clamp (included) under chassis:
16-16 uF at 450V 2.95 **16-16-16 uF at 450V** 3.95
Sprague 800 volt 715P polypropylene cap, your choice .0033 or .0047 uF .29 each
HV Polypropylene, your choice .001-1500V, .0015 1KV, .0047 1600V, .0068 1KV .39 each
Roderstien .037-400V axial polypropylene .29 each
Sprague 410P Axial .15 uF 300V .29 each **F-Dyne** .022-400V axial pprop .29 each
ALPS 50K stereo combo Volume & Balance control, large case,detents 4.95
Noble 250K,100K,or 25K dual volume, cast case,conductive plastic 19.95
Filament Transformers 2.5VCT 3 amp, 3.95 6.3V 1.2 amp, 3.95
Terminal strips, Phenolic Bag of 30 pcs 1.95
Soldering Irons, big ones for thick metal.Wood handle.60 watt 4.95, 100 watt 6.95
Transformer, #23V17 (Thordarsen) 117V 300 ma , open frame 9.95
Choke,Stancor #C2344 1.5H 10ma, 1500V hipot 1.95 ea
Choke, #LC9121, 600 mh 600 ma, 18 ohms DCR, 1.95
Octal ceramic socket, EBY USA, fits standard 1 1/2" mounting centers, mil spec 7.95 each
Teflon silver plated wire, 20 ga, asst colors 18" pieces 10 ft+ total, 1.95
Metal Film resistor kit,100 pc, 20+ popular values 1/2 watt 1% 6.95
Power Resistor Kit, 100 pc,20+ pop values 3 to 7W metal oxide 12.95
Thermistor Kit, slow turn on devices, 10 pcs asst ohms, 2.95
Time Delay Relay, 6NO60T, 30 sec, 6.3V acutator, 9 pin base 4.95
Fun Tube Facts: The 8941 planar triode is only 2 1/4 inches (56 mm) long and weighs only 2 ounces (56 grams), but is rated for 5,000 volts on the plate (anode), has 750 watts of anode dissipation (with a heat sink adaptor), and can pass a 3 usec pulse up to 4 amps (thus generating a 10,000 watt pulse!). The mu factor is 200 with a transconductance of 75 ma/V (75,000 umho). They are generally intended for advanced aerospace use and have a list price of $1,200.

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If you want to pick up parts at the office, please note: We can not allow persons to"browse" the warehouse. Please phone 1 day in advance to pick up parts.
Thanks for your help..Until we get a larger facility unfortunately we will have to ask our generous and understanding customers to suffer with occasional busy signals, due to the number of overseas calls we recieve we cannot use voice mail or put customers on hold for very long.
We are here and better than 90% of orders are shipped within 1 business day..
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I found that by buying parts in OEM quantities without the fancy labels I could save you a bunch of money.Mystery Parts make experimenting and restoring vintage gear affordable for the average person.

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RCA Jacks, gold plated with teflon insulation and teflon washer to insulate from chassis. Same as "Royce-style" we used to sell. Specify Red or Black 2.95 EACH
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Metal Gold Binding Post, with color-coded insulating washer. 15A capacity. Specify Red or Black. 2.95 EACH
Banana Plug, gold, takes up to 10AWG cable. Specify Red or Black. 2.95 EACH
Spade Lug, gold, takes up to 10AWG cable. Specify Red or Black. 2.95 EACH
SuperFlex 12AWG OFC copper speaker wire for use with above plugs/lugs.
259 strands #36 wire rope lay. Roll of 25 feet (about 8 meters) 13.99 per roll

Mystery Polystyrene Capacitors

Hard to find high voltage values.
These types rated 630V, 1% tolerance: 10 pf, 12 pf, 15 pf, 18 pf, 22 pf, 27 pf, 33 pf, 47 pf, 56 pf, 68 pf, 82 pf 1-9 pcs 1.95 each, 10-24 pcs, 1.59 each, 25 + pcs 1.35 each
Rated 630V, 1% tol: 100 pf, 120 pf, 150 pf, 180 pf, 200 pf, 220 pf, 270 pf, 330 pf, 390 pf, 1-9 pcs .99 each, 10-24 pcs .79 each, 25 + pcs .69 each
Rated 630V, 5% tol: 470 pf, 560 pf, 620 pf, 680 pf, 750 pf, 820 pf
1-9 pcs .69 each, 10-24 pcs .55 each, 25 + pcs .49 each
Rated 630V, 5% tolerance: 1000 pf, 2200 pf, 3300 pf, 4700 pf
1-9 pcs .49 each 10-24 pcs .39 each, 25+ pcs .35 each

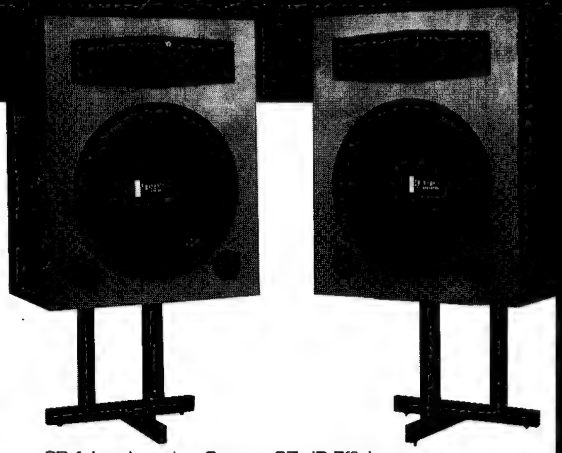
Mystery Polypropylene Capacitors.

All 10% tolerance. Quantity discounts as follows: 10 to 24 pcs, 20% off, 25 or more 33% off. Over 100 pcs please call for quote.
Rated 630V: .01 uF .45, .022 uF .45, .033 uF .45, .047 uF .45, .1 uF .60 .15 uF .75 .22 uF .75, .47 uf .95 1.0 uF 1.50 **Rated 400V:** .15 uF .50 .22 uF .60, .47 uF .75

Other Regular Stock Useful Items

Mallory Twist-Lok Capacitors, new (1993 date code!) 1 3/8" (35mm) base unless otherwise specified
20-20-20-20 uF at 475 volts FP-475 14.95 **20-20 uF at 450 volts** FP-234 1" (25mm)can 10.95
Computer grade capacitors, clamp mount 1 3/8" dia. Made in England
220 uF 500V 9.95 multi section **50+50 at 500V** 7.95 Clamps add 1.50
Axial Electrolytic Capacitors Other lower voltages also stocked
500V:22 uF 1.95 47 uF 3.95 100 uF 7.95
450V: 10uF 75¢ 22 uF 1.25 33uF 1.65 47 uF 1.95 80 uF 2.50 100 uF 2.95
5 watt Zener diodes, your choice 47, 82, 100, 110, 120, 130, 140, or 150 volts 1.95 each
Diodes, 1N4007 1A 1000V, pack of ten, .95 **2.5A 1000V** pack of five .95
High Voltage Diode, 500 ma 12,000 volt PRV rating (wow!) 5.95 each
Clarostat 2 watt linear controls, for bias/balance,etc. 1K, 5K, 10K, 25K, 50K, 100K 5.95 each
Polycarbonate hospital grade **power plugs**, USA mfr, 2 or 3 prong, 4.95
Neutrik XLR connectors gold plate contacts, black case, specify male or female, cord or chassis mounting. 4.95 each
Chassis boxes (see cages below) for tube power amps, 9X5X2 alum 13.95 12X8X3 alum 22.95 16X8X3 alum or steel 25.95 17X10X3 alum or steel 28.95 17X14X4 steel 44.95
Bottom covers and feet included. Aluminum chassis are natural, steel are grey enamel.
Cages for above chassis, perforated enameled steel,5" vertical clearance, 9 X 5 $30, 12 X 8 $30 , 16 X 8 $33.00 and 17 X 10 $34 each
Punch Kits, will punch all chassis above (up to 18 ga steel), covers all popular tube socket holes, 5/8", 3/4", 7/8" , 1", 1 -1/8", 45.95 each
Lettering kits, dry transfer, for marking above or other chassis. **Specify Black or White.** Choose **Audio Words** (#AUD-1) **Terminal Letters and Numbers** (#TC-13) or **Dial Marking** (for volume/selectors,etc) (#DM-13) Large pack $3.29 per pack.
FM Radio Alignment Tool Kit, has most popular types. #AT-1 1.95
Sockets, Octal (for GZ34 ,EL34, 6550, 6L6,etc tubes) British Micanol (brown plastic) (McMurdo) phosphor bronze contacts,standard 1 1/2" mnt centers 1.95 each
9 pin chassis mount McMurdo socket, similar to above 1.95
Ceramic Octal with Gold plated contacts, direct fit for Dynaco, 6.95 each
Ceramic Octal with silver plate contacts, slightly smaller than above item. 2.95 each
9 pin ceramic/gold, PC or Chassis mount, **fit** USA dimensions, exc quality 5.95
9 pin white plastic/gold PC mount very nice 2.95 Same item no gold plate 1.95
9 pin chassis mnt, ceramic/silver with shield included,fits 12AX7,6DJ8,etc 1.95
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Cinch 9 pin chassis mount socket, black plastic, ground lugs .95
Have Tube Sockets and Top Caps of all sorts.If you don't see it here please ask.
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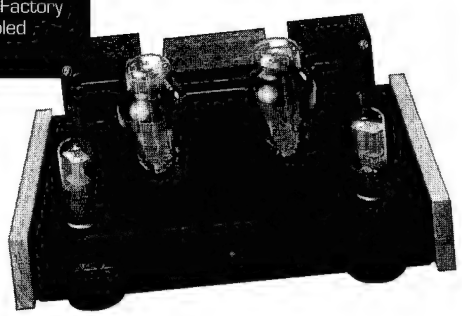
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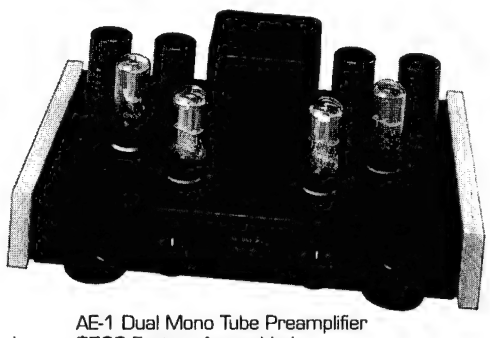
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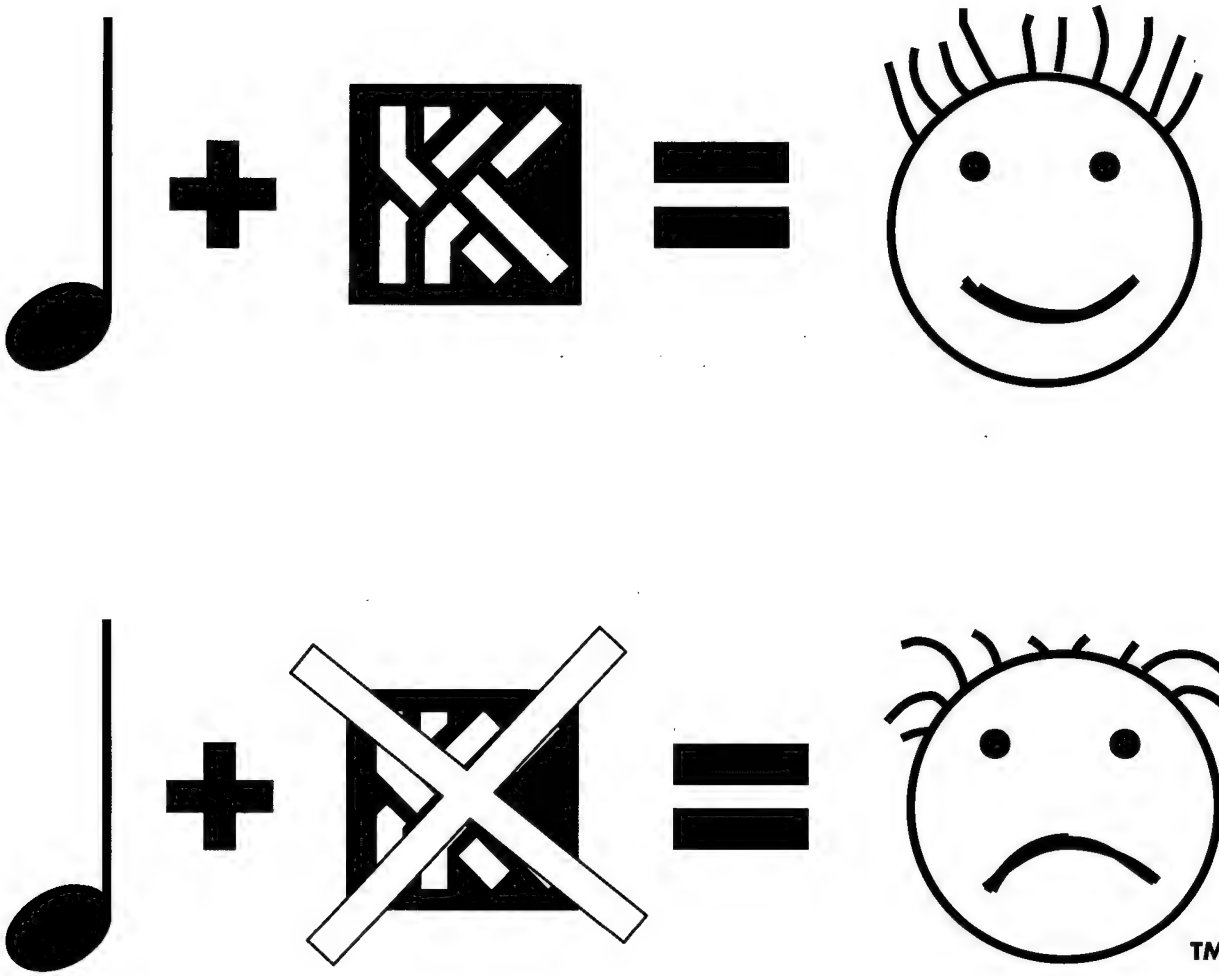


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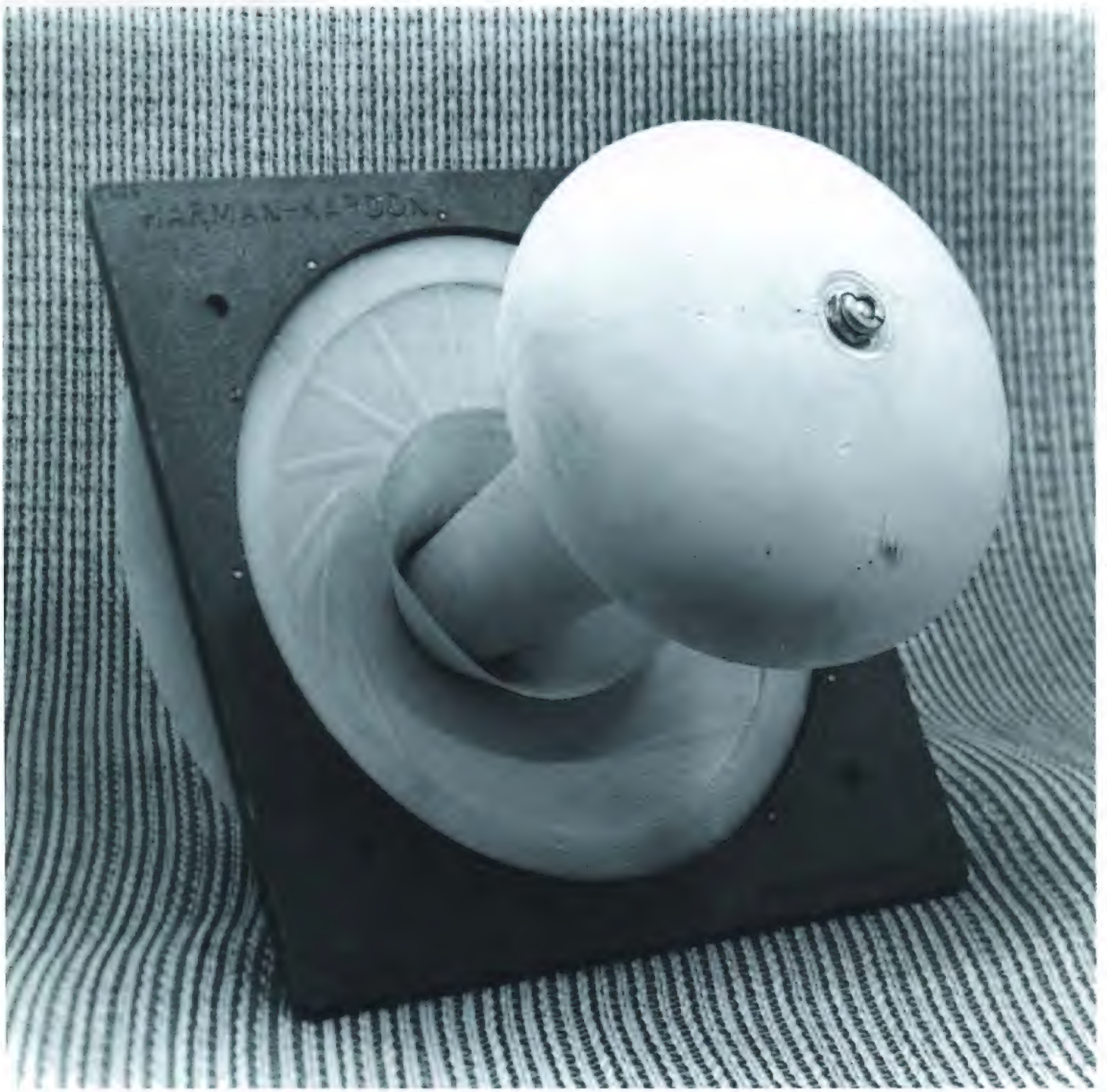
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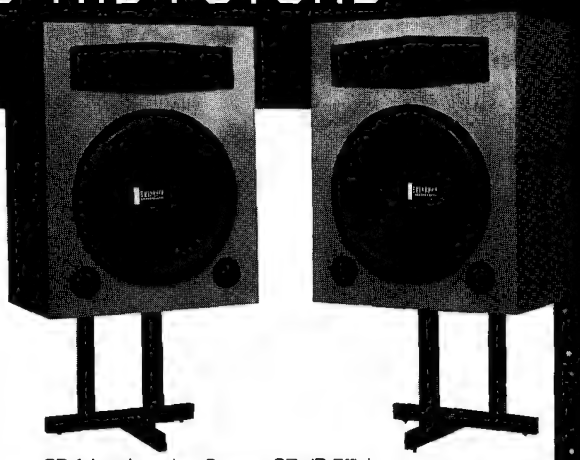
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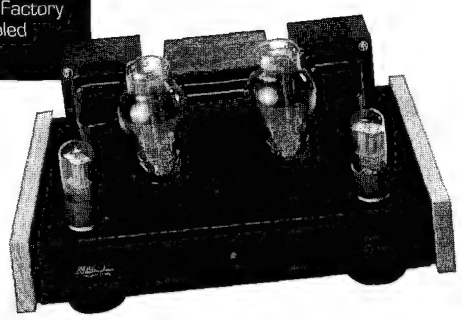
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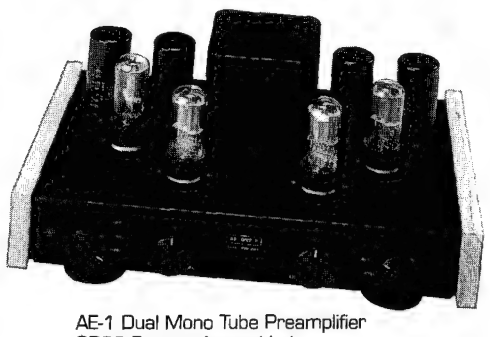
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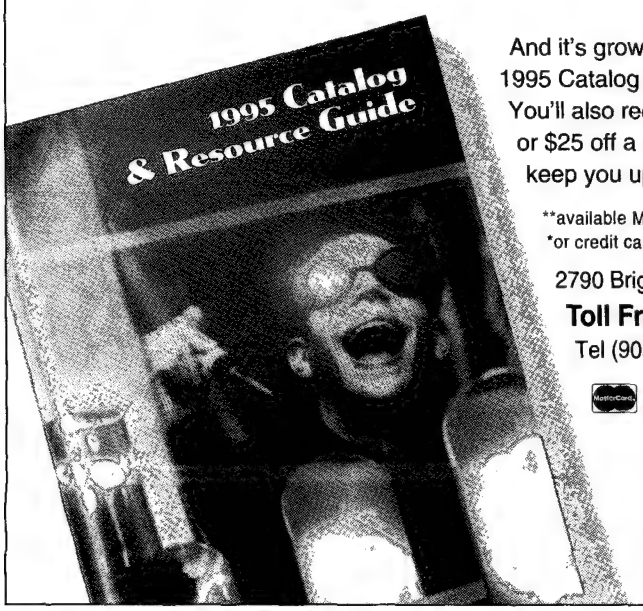
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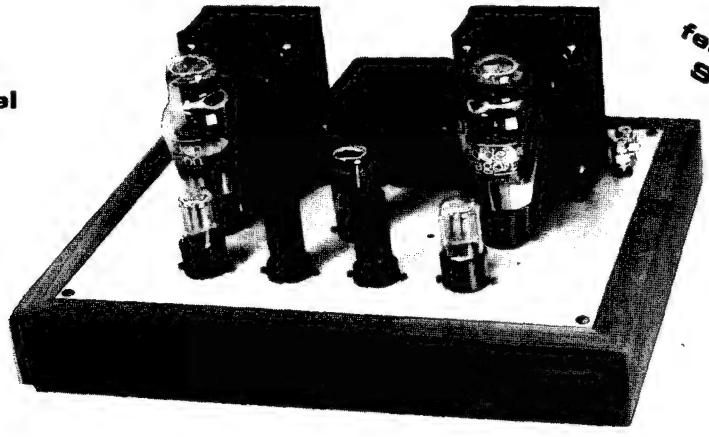
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This publication exists to encourage audio experimentation and to promote the exchange of related information. Opinions expressed are those of the authors and may not reflect the opinions of any other person or entity.

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. . . and MUCH MORE!!!

The information explosion

Considering the vast possibilities of the written word, it is unfortunate that every major audio magazine these days follows the strictly-commercial "formal review" format. Sure reviews bring in ad revenue and, true, most readers do like to read about new gear. Granted that some review content is both necessary and desirable, one can still argue that large circulation mags could be a lot more than just show reports, endless reviews, recommended component buyers' guides distilled from reviews, and pricey four color ads featuring quotes from reviews in fancy italics.

Back in the 1950s when Hi-Fi was getting started, newsstand audio magazines were focused on the practical ways of sound technology. There were lots of good entry-to-mid-level technical articles, often written by practicing engineers and manufacturers sharing the dope on their latest gizmos. Product reviews were rare and usually limited to a few crisp paragraphs in length when they did pop up. You could actually learn something from mainstream hi-fi mags back in the old days, even if 50% or more of what you were reading was total bunk, just as it is today.

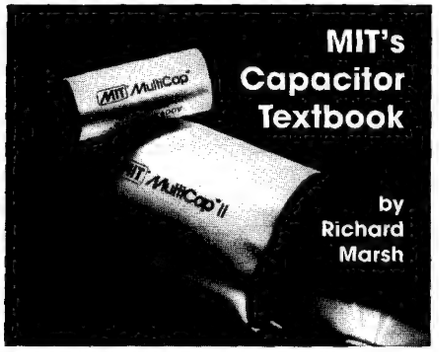
Big audio mags went downhill when all them damn "professional reviewers" nosed into the act, filtering the whole discourse of audio electronics and audio aesthetics down to 2500 word diary-style confessions reliving the neurotic process of formally evaluating item *x*. Even when done well, reviews tend to be more about the psycho-drama of the author's mind than about the gadget under review. On the whole, the formal review is one bone-dry, overworked, and tedious literary formula. How many picky distinctions can one writer make in a single year? How many can you stand to read?

The ultimate tragedy of the formal review magazines is that in exchange for all that highly-skilled editorial effort, acres of fallen timber, and 50 gallon drums of color ink, next year all we'll have to show is a tall pile of boring out-of-date reviews and at most an xtra-slim sheaf of solid articles worth saving to *re*-view for educational purposes.

Thankfully, a popular revolution in audio publishing has been brewing these last few years. The info gates open wider by the month. Lively new labor-of-love small press magazines are popping up everywhere. Some focus on highly esoteric subject matter. Some do reviews in their own ways, some are like scientific journals, and a few are into personal essays, parody, and other literary genres. With some mags, you never really know what to expect upon turning the page. Of course, some of it is nonsense, but at least it's *fresh* nonsense. None of these small axe publications threaten to blow the big boys off the newsstand this year but the beneficial effects of a broadening public dialogue are accumulating.

I can't remember ever encountering such a w-i-d-e variety of audio opinion on the street as we have today. In the new magazines and in the online universe you get to hear a whole chorus of audiophile voices besides the steady nasal drone of the priestly class of pro reviewers. Thanks to the spread of PC communications and affordable desktop publishing, manufacturers, hobbyists, and experimenters—i.e., people who actually *do* things—are getting their ideas and insights into general circulation through the side door.

Ideas move progress and there are a lot of them flying around right now, faster and hotter and farther than ever before. As a result of this beefed-up information flow, we're getting back to a sense of wonder and the kind of productive confusion that can lead to a better audio future and a deeper understanding of our craft over the long run. That's the way it should be.



Debunking the Myths

Cap Myth # 1
Silver, gold, or stranded lead wires make an ordinary, single-wind cap sound great!

Cap Fact
The body of the capacitor - not the lead - brings about superior performance:

- On any component part, the shorter the lead, the greater the overall sonic performance.
- PCB mounted caps have leads cut to 1/8 to 1/4 inch long.

Result: The rest of the expensive lead metal is tossed away!

- Stranded leads don't fit easily into PCB holes & loose strands reduce reliability & can cause shorts in the circuit.
- Stranded leads reduce capacitor performance by allowing air, moisture & contaminants into the body of the cap through the gaps between strands. Lead insulator material cannot bond as well to the protective epoxy end-fill seal.

Result: oxidation & corrosion within the cap

Result: increased distortion (ESR), potential cap failure, degraded sonic quality over time

Solution?
MIT's **MultiCap** leads are single, heavy-gauge tin-coated copper, which forms an excellent seal to maintain low ESR and phase anomalies over time.

In addition, the MultiCap's internal bypass design reduces distortions and saves time & space, insuring immediate value & top performance over the life of your equipment.

Call for copies of Richard Marsh's articles from Audio, The Audio Amateur, and TAS, and MIT white papers on capacitor design.

And watch for Cap Myth # 2: Plate Materials!

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New Products



SHORELINE 800

Grown weary of the power limitations of your single ended 2A3? Looking for an unquestionably stout bass amp for your biamp system? Step up to the Shoreline 800 from Rainbow Electronics, without a doubt the biggest and baddest vacuum tube amplifier on the block.

Each 350 pound monoblock delivers 800 Watts continuous and 6 kilowatt peaks, thanks to the push pull parallel 813 beam power transmitting tube in the output stage. The quantity of current available out of the wall is the limiting factor for peak output in this design. A switch is provided to use only one pair of output tubes in case your circuit breakers can't take the stress or your air conditioner can't keep up with the heat. The 800 comes fitted with grand piano castors for easy mobility.

Shoreline designer John McCormack preaches that POWER is the key to live sound. He claims that the sonic vibrations from the Shoreline 800 travel through walls as if they weren't even there, yet the amps don't sound "loud" even when hooked up to his horn loaded super high efficiency reference loudspeakers and turned up a few notches past sanity.

The $100,000 per pair Shoreline 800 gets its name from McCormack's highest goal as an audio designer: to recreate the majestic sound of the ocean crashing against the shore with full impact and presence. Remember when you were a little kid on the beach and the sound of the surf enveloped you? That's the ideal that the Shoreline aspires to recreate.

The argument that tens of thousands of watts is required to reproduce the true dynamic range of naturally occurring sounds is not a new one, but the Shoreline 800 is the first vacuum tube audio amplifier intended for in-home listening that really takes the concept seriously.

Despite its previously unheard of power delivery capability, McCormack views the Shoreline 800 as a mere starting point power-wise. He says that if you really want to experience the sound of the seashore in full glory, you'll have to wait for the Shoreline 25000!

Rainbow Electronics
5800 Madison Av., Suite G
Sacramento, CA 95841
916-334-7277 VOICE
916-334-7280 FAX





BLUE THUNDER

by Christian Rintelen and R. Luigi Andreoli

It all started with commercially available 94dB/W/m speakers and a custom-built triode amplifier. The virtues of this combination were evident — but so were its flaws. As always, different component swaps confirmed that the speakers were the weak link in the chain.

We looked and listened around for a speaker that would enhance the strengths and tone down the weaknesses of that configuration. But no commercially available speaker met all our requirements: they were either too big or too ugly or colored too much or did not match the amp or . . .

In short, we decided to start from scratch and build a speaker exactly to our taste.

Building a speaker always means dealing with compromises. The no-compromise speaker does not exist, despite all claims by manufacturers. Satisfaction has a lot to do with defining goals and being fully aware of compromises. There will still be a lot of surprises to handle during the process, but it's better to start with fixed goals. Otherwise, it's a never-ending story.

We defined our ideal speaker as follows:

- It should be a true full-range speaker with drivers that handle as much bandwidth as possible, preferably two-way.
- It should be of high efficiency (SPL over 100 dB @1W/1m).
- It should be easy to drive for triode amplifiers (loads, resonances).
- Its sound should be powerful and dynamic — yet natural, detailed and as uncolored as possible.
- It should not only please the ears, but also the eyes.
- It should work well in medium-sized (i.e. 30 m^2) rooms.
- It should not require a listening distance of more than 4 meters.

We couldn't use the room corners for various reasons, so we had to forget about corner horns like certain Klipsch or Lowther designs.

Which way to go? Our goals were lofty and the restrictions clear. We thus decided from the very start that we were willing to invest in the best available components.

The demand for high efficiency and pleasing esthetics narrowed the choice down to reflex port bass and horn-loaded upper bass systems or Onken-like cabinets. Going two-way all the way, on the other hand, required a driver that could manage all frequencies above 500 Hz. Furthermore, such a driver should be horn-loaded to assure homogeneity with the presumably horn-loaded bass.

There are not many high-efficiency drivers that fulfill these requirements. But an evaluation of the different possibilities showed that one driver was perfectly up to the task—the TAD 4001 compression driver. This 2 inch unit with a beryllium diaphragm has a flat frequency response from 600 Hz to well above 20 kHz and a 12 ohm impedance at the crossover frequency range.

Efficiency is around 110 dB/W/m, due to the 2 kilograms of Alnico magnets. The compression driver weighs a hefty 13 kilograms.

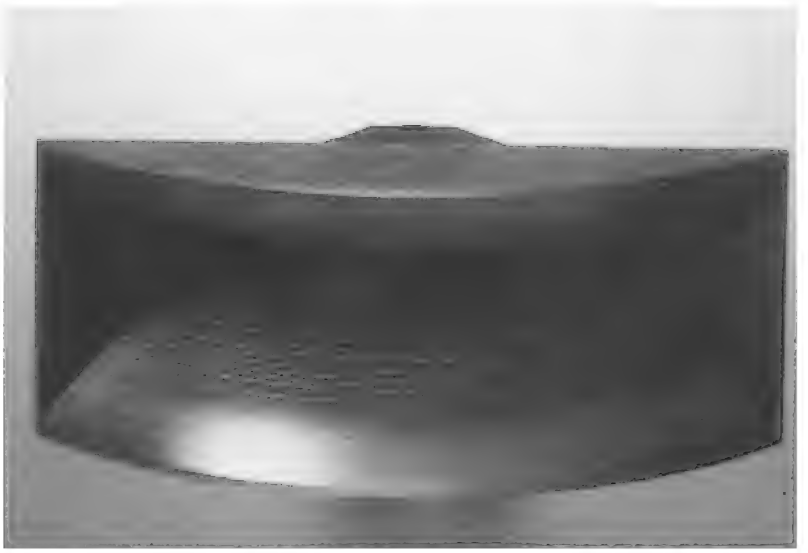
Designing a horn that covers such a wide frequency range with uniform sound dispersion and without high frequency rolloff is a tricky job. We thought about building our own horn using a Hypex or Tractrix expansion. Doing so would require a lot of work and money without guaranteed satisfaction. TAD, on the other hand, offers a horn especially designed for the 4001 compression driver. We decided to go for that option, assuming that the guys at TAD surely know how to tweak the best out of their drivers. After all, their driver/horn combination is considered hot stuff in recording studios all over the world. [*and well received in global audiophile circles, except in the US market where a decades-old divide between pro and high-end gear has prevailed. Of course, the price of the top professional compnents like TAD is somewhat restrictive but Class A high-end speaks ain't cheap either —ed.*]

The TAD horn width is 61 centimeters — a measurement of some significance since we didn't want the speaker to look like a haphazard stack of boxes. The original Onken design is some 80 centimeters wide. Putting the TAD horn on top of it would have been an eyesore. In short, the cabinet of the bass speaker should also be 61 centimeters wide.

This ruled out any Onken-style cabinets with 15 inch woofers, since the area of the reflex openings on that design is equivalent to the driver surface. The Onken bass enclosure was originally designed to be used with transistor amps (even the models with the reduced vents are reported to have a slightly lumpy bass with tube amps compared to transistor designs). It would also have needed a large lower midrange horn to offset the decreasing sound pressure of the direct radiating woofer, so we decided against it.

Comparing the different driver options for the woofer, we went for the Focal Audiom 15 VX II instead of the Altec 416, since the latter needs a 30% larger enclosure volume for the same bottom end. Horn loading all the way down was out of question, since the opening required for 25 Hz would be $4m^2$!

So we settled for a vented cabinet with horn loading down to approximately 120 Hz, similar to the Voice of the Theatre. Tractrix or exponential? The Tractrix curve horns sound good in the 150 to 500 Hz



TD-4001 High-Frequency Driver

The TD-4001 successfully achieves all the design objectives we set forth — very high efficiency, wide and perfectly flat response from 600Hz to 20kHz, and low distortion.

DIAPHRAGM. The TD-4001 employs a pure beryllium diaphragm 3-15/16 inches (100mm) across. Beryllium is a light but very rigid material that features very high-speed sound propagation. The weight of the dome section has been reduced to a mere 1g, contributing to the very high efficiency (110dB/W) of this driver.

VOICE COIL. The TD-4001 employs an aluminum ribbon voice coil, insulated by alumite film and wound edgewise on the bobbin. The voice coil has a small mass yet offers a high conversion efficiency. The bobbin is formed of polyimide film, displaying excellent heat resistance to temperatures as high as 752°F (400°C).

MAGNETIC CIRCUIT. Total magnetic flux is 228,000Mx, with flux density of 20,000G, thanks to the use of a very heavy (6 lbs. 10 oz./3kg) alnico 5DG magnet. An oxygen-free copper shorting ring prevents impedance rise, resulting in low distortion.

DESIGN. The TD-4001 is of the rear compression design, which eliminates the resonance and phase distortion produced by a surround. It also eliminates cavity resonance interference, achieving very flat frequency response, extremely natural sound and superb definition. A phasing plug helps smooth the response of extra high frequencies.

CROSSOVER. We recommend the use of a crossover frequency of 600Hz or higher, and a cutoff slope of 12dB/oct. or sharper.

TD-4001 SPECIFICATIONS

Voice coil impedance: 16 ohms **Voice coil diameter:** 4 inches/101mm **Equalizing system:** 5-slit type **Frequency range:** 600 — 20,000Hz **Maximum input power:** 60 watts (600Hz, – 12dB/oct.) **Sound pressure level:** 110dB/W (1m) **Crossover frequency:** over 600Hz (– 12dB/oct.) **Total magnetic flux:** 228,000 maxwells **Magnetic flux density:** 20,000 gauss **Hole size for throat connection:** 1-15/16 inches/49.4mm **Mounting dimensions:** 4 inches/101.6mm (4 holes) **Weight:** 29 lbs. 12 oz./13.5kg **Outer dimensions (diameter × depth):** 7 × 6-1/8 inches/178 × 155.5mm

TH-4001 Stabilized Dispersion Horn

The TAD TH-4001 is a stabilized dispersion horn designed specifically for use with the TD-4001 high-frequency driver. It allows you to exploit the wide frequency response of this unit, providing excellent dispersion of all frequencies, including high frequencies above 10kHz, a feat rarely achieved by large horns. The dispersion pattern is optimized, based on our measurements of actual room acoustics. As a result, the entire output of the TD-4001 is uniformly distributed over a large area. High resolution is another result of our acoustic engineering. The horn is made of genuine maple, for clean, rich, natural sound.

TH-4001 SPECIFICATIONS

Type: Stabilized dispersion horn **Cut-off frequency:** 320Hz **Flare type:** Hyperbolic curve **Radiation angle:** 90° (horizontal)/40° (vertical) **Throat diameter:** 1-31/32 inches/50mm (suitable driver throat diameter: 1-15/16 inches/49.2mm — 2 inches/50.8mm) **Driver mounting system:** P.C.D. 4 inches/101.6mm L90° 4 bolt mounting **Weight:** 24 lbs. 11 oz./11.2kg **Outer dimensions (W × H × D):** 24-1/8 × 9-7/16 × 16-1/8 inches/612 × 239 × 410mm **Accessories:** Horn mounting hardware pieces × 6, Washers × 6, Bolts with hexagonal heads × 6

US office for TAD Professional Components: Pioneer Electronics Service, Inc., PO Box 1750, Long Beach, CA 90801 Voice 800-872-4159 FAX 310-952-2821

Catalog Descriptions of Technical Audio Devices Horn and Driver



Highpass filter with 0.2 dB per step attenuator, 1.2 mH/0.13 Ohm DCR coil, and five PP caps bypassed with a tinfoil cap shown mounted behind the TAD horn

Interior view of bass cabinet.



The interior of the cabinet is lined with black acoustic foam. No further stuffing was used.

Birch plywood "sounds" very nice and is ideally suited for this kind of speaker, but it is a real pain to work with.

Note the two hefty (10 kg each!) 0.27 mH 0.17 Ohm DCR coils made of 5 mm^2 wire used in the symmetrical low pass filter.



range. In addition to this, a Tractrix curve would allow a nice visual effect because the 45 degree angle of the cabinet walls blends perfectly with the miter joints we intended to use for the cabinets. According to Dinsdale's and Lambert's work, the true cutoff in a Tractrix horn occurs at the 70% to 80% point of the mouth area — the cabinet walls precisely made up for this percentage.

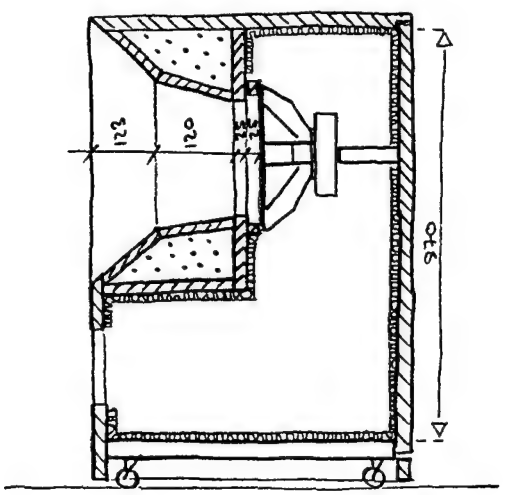
The Audiom driver needs a volume of about 220 liters (0.22 m^3) in a vented cabinet to produce bass down to 40 Hz. Add that to the volume of the horn plus the massive plywood, and you get a fairly big cabinet. With the front being relatively narrow, the speaker looks impressive but neither intimidating nor overly conspicuous. The finished speaker is 61 cm wide, 125 cm high, and 70 cm deep (including midrange horn). It weighs approximately 150 kilograms. The finish is clear lacquer for the enclosure and dove-blue Nextel for the Tractrix horn and the crossover box.

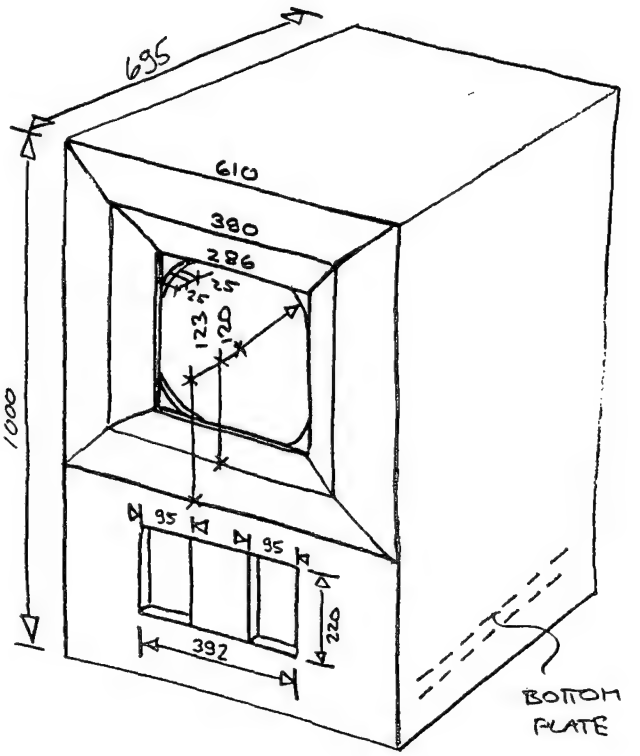
The speaker was intended to be used in bi-amp setup using two stereo amps with 6336 dual triodes in the output stage. The amp allows one to drive the twin power triodes either P-P or SE, since phase-splitting is done in the pre-amp and the four channels of the power amps are each connected with two coaxial leads carrying the 0 and 180 phase signal. For push-pull, both input signals are connected and both sections of the 6336 are driven. Conversion to SE can be done in two seconds by disconnecting the phase inverted input signal, so only one section of the twin power triode is driven. We use P-P for the bass and SE for the midrange.

The crossover frequency is 560Hz with a 12dB design using two huge coils in the bass to minimize DC resistance. We chose a symmetrical configuration since the output transformer of the amp is not grounded. This allows the woofer to be driven equally on both leads. The crossover for the TAD can either be used in a conventional configuration for single amp operation with a stepped attenuator providing 0.2 dB steps or with the attenuator bypassed for bi-amping. The choice of excellent drivers allows simpler crossover designs since you don't need extensive filtering to fix any inherent glitches and flaws.

The Audiom woofers were "burned in" for three days with different frequencies before mounting. Despite our best efforts at initial break in, the bass reproduction continued to improve significantly for half a year!

Simplified Version of Tractrix Upper Bass Horn





	Birch plywood	30mm
	MDF	25mm
	Birch plywood	40mm
	Glass blast powder density	2,86

Speaker cabinet: 30mm high density birch ply
Horn: 25mm MDF
Bottom Plate: 40mm birch plywood

We selected 30 millimeter birch plywood for the cabinet in order to raise cabinet resonance to a point well above the radiated frequencies. The Tractrix horn was made of 25mm MDF — a wise choice considering the many odd angles of the Tractrix horn. The cavity between Tractrix horn and cabinet was filled with sandblast-grade glass beads.

Like everybody, we wanted a speaker capable of credibly reproducing all kinds of recorded music. To us, this "credibility" includes (among other criteria):

- Convincing micro- and macro-dynamics
- Timbral correctness
- No disturbing coloration in any frequency range
- Credible reproduction of sound stage depth and width
- Authority (i.e. the necessary body and air real music has).

Just a brief description of what we ended up with — as unbiased as possible: the speaker produces a big, emotionally involving, but nevertheless precise and thus credible reproduction of the recorded event. It does not turn a lousy recording into gold, but even mediocre recordings and pressings really shine.

The bottom end has tremendous energy and authority. It is fast, colorful, tight and controlled without audible cabinet resonances. It really moves air when kick-drums are kicked. The far left of a piano has the necessary attack and speed to be considered "almost real." Plucked bass is reproduced sonorously with plenty of snap and color.

The midrange is seamless and very homogeneous, despite the crossover in the critical 500 Hz range. Harmonics of bass instruments really "sing." Forget any prejudice about horn speakers not being suited for voices — the TAD sure is. The highs are neutral, extended and sweet. Hot or bright recordings can be tamed by the very fine increments of the attenuator. What is especially pleasing with this two-horn speaker: you don't have to move 6 meters away to get homogeneity and a seamless blend of the two horns — 3 meters is enough.

We are happy with the result. Of course, the speaker is big. But it integrates well into rooms that measure 30 m^2 or more. The money spent on excellent component quality was well invested. Our recommendation to all DIYers: Don't build a big speaker with little money — build a small one with the best components you can afford. It certainly pays off!

The perfect speaker does not exist! A fully horn-loaded bass, for instance, would speed up the bass even more. A super-tweeter above 15 kHz would probably add some extra air and reduce the directionality of high frequencies. And who knows how much more magic a SE 2A3 amp with built in passive crossover would add to the TAD drivers? But that's another story.

The authors:
Christian Rintelen is a free-lance writer and spends his spare time editing *HiFi Scene*, a Swiss nonprofit underground magazine. Luigi "Blue" Andreoli studied architecture and design. After completing his first houses, he decided that hi-fi is more fun. He hand crafts everything from MC cartridges and amps to speakers of any size. Christian and Blue live in Zürich, Switzerland.

ed.- Hi-Fi Scene is one of those mags like *MJ* from Japan and *Costruire Hi-Fi* from Italy that makes a poor monoglot like me wish that Esperanto was the world language. Every *progressiver* audiomaniac would enjoy the vision this *"von Kennern für Kenner"* German-language magazine offers. Write Christian for more info on this *inspirierte Zeitschrift.*

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THE LOWTHER-VOIGT LEGACY

Haden Boardman, Mellotone Acoustics

Getting hot under the collar? Cannot find that 100dB/watt speaker to use with yer flea powered single-ended tube amp? Fed up with power sapping crossovers, misaligned phase fouling multiway speakers? Tired of that metal dome tweeter ting and over Q'd bass? Well, read on.

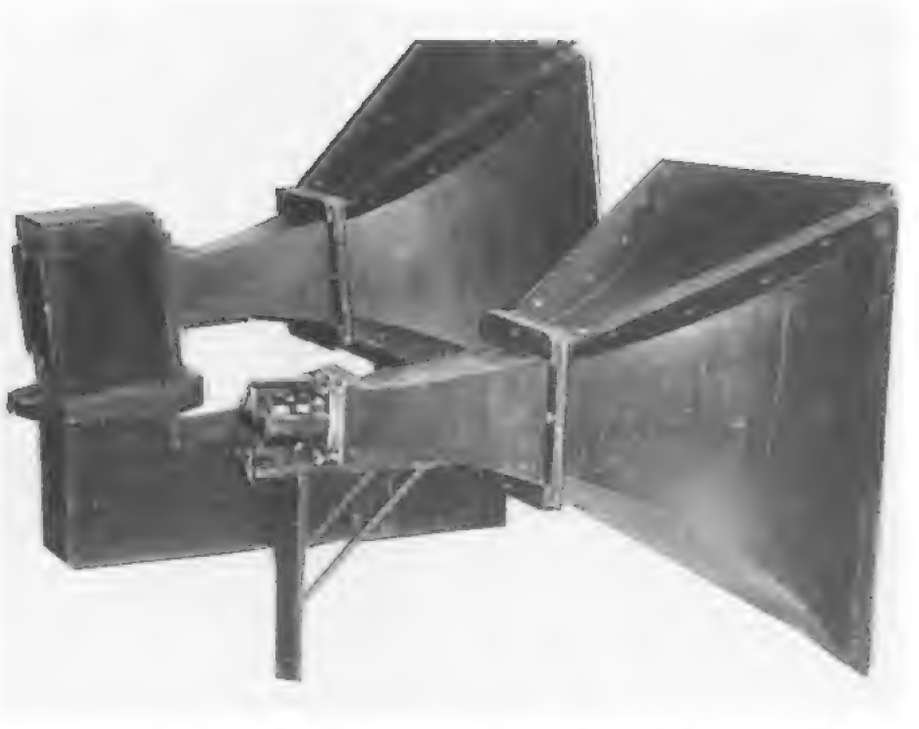
Most multiway speakers suck—period. 99% have crossovers in the 500-5000 Hz range, the area that your hearing and brain are most sensitive to.

Worse still, most makers add a "phasey" dome tweeter (any dome tweet, not just metal 'uns) to the act. The idea of the dome is to disperse the sound as far as possible. The problem is the sound "bounces" off the tweeter's face plate, the loudspeaker cabinet and nearby furniture. This gives the travelling sound wave a small amount of delay, which permanently "masks" the original fine imaging details of the recording, resulting in only LEFT - CENTRE - RIGHT imaging with no, or at least very little, depth of image. Stereo is supposed to be "3D", you do not need surround sound or quadraphonics to fill your room with "3D" sound.

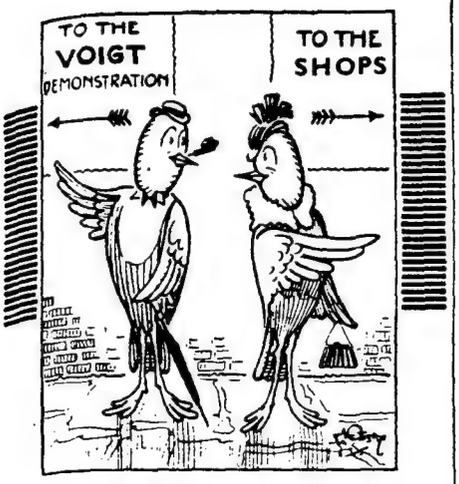
The final problem with "domes" is the fact that most of the dome stays still, most of the sound comes off the edge of the voice coil rather than the mass of the dome. Imagine for a moment, you have a 16mm diameter voice coil dome tweet. 16mm is the full wave length of a 20,625 Hz wave form. Or more importantly, half a 10,312.5 Hz wave form. So if you sit at an odd axis, the sound from the edge furthest away could be out of phase with the edge closest to you. The result is partial cancellation. In practice this is a bit simplistic, but most seem to have ignored the facts, otherwise I am very sure the devilish things would not be so popular.

If you want good imaging, speakers SHOULD be directional, only then can they convey the original imaging data encoded in the original stereophonic signal.

Take the LS3/5a and Spica TC50s. Both speakers go out of their way to mask the diffraction and create a controlled dispersion pattern that at least tries to be in phase with itself. Both speakers have a good reputation as far as imaging is concerned. One has to wonder how much better these loudspeakers could have been if the designers had used a cone tweeter instead — presuming that any of the "big boys" in the loudspeaker chassis OEM market made any decent ones.



Original Voigt wooden tractrix cinema horns from the 1930s

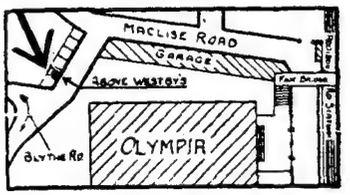


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1939 Voigt Patents Ad

The Voigt Legacy

Back to the thread, there is one speaker that is not hard to construct, is efficient, has output past 20 Khz, with no bloody treble ting or bass boom. It is based on the work initially of one gentleman, Mr. P. G. A. H. Voigt.

Back in the 1920s Voigt worked on the design of the moving coil loudspeaker, while unknown to him at the time, Rice & Kellogg were working on a very similar design, both using a medium sized 6 1/2 inch cone. R & K beat Voigt to the patent, thus denying Paul Voigt whatever fame and fortune was involved.

At this time, Voigt was working for a small English company, J.E. Hough, Ltd. (which later became Edison Bell), manufacturing radios and records. It was here that Voigt patented an early condenser microphone and all electric recording cutting system, instead of the purely acoustic method.

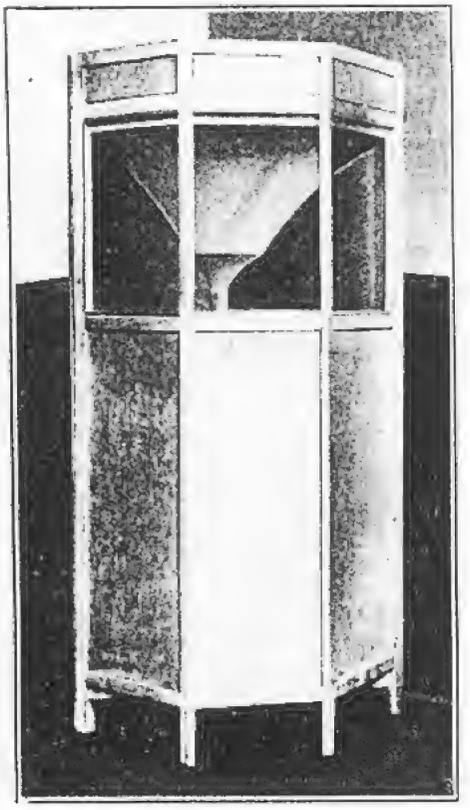
Voigt then left this outfit and set up his own company, Voigts Patents Ltd, after Edison Bell crashed in the Great Slump of 1933. It was now that he began to produce the famous Voigt Corner Horn, which had a mains energised (200 volt, 42 watt) field coil, a single six inch cone, front mounted tractrix horn for the mids and highs and a quarter wave "bass chamber".

A few years later, Voigt patented the "twin cone" cone. If the guy had earned a penny for every twin cone loudspeaker produced after his patent lapsed, he would easily have been a millionaire several times over. This was added to the Corner Horn, with another clever idea — a double wound voice coil. This must be a pain in the ass to make. The only way I can see it being done is to wind the first coil onto a "forming" rod, wrap the voice coil card over it and then wrap the second coil over the whole lot, presumably adding lots of glue as you go. Incidentally, the voice coil is wound with aluminum wire.

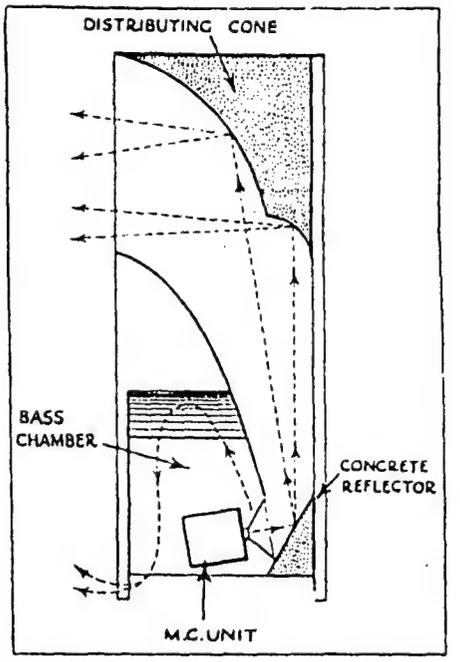
The cone itself is folded from a flat piece of trimmed-to-shape paper, the whole thing held together by glues, lacquers and varnish. Operation of the Voigt Voice Coil spider is very impressive. The cone was terminated in a soft roll surround.

At the same time in the 1930s, another small company was prospering with its "high quality" wireless and gramophone equipment. This company was called "Lowther", run by a Mr. Peter Lowther. The two names were eventually tied up in a marriage that has lasted until the present day.

I often wondered what was the point in making "high quality" equipment, when you



Designed to fit into a corner of the room the latest Voigt domestic speaker has similar characteristics to those of a 4ft.-mouth horn.



The Voigt Corner Horn of the 1930s used reflectors to tame the directionality of the driver and spread out the sound, making a single speaker sound like a whole band. Perhaps this idea was 100% right for mono but it's 100% wrong for stereo, where the strong directionality of an "unreflected" Lowther driver assists stereo imaging and dimensionality.

played your records with a pick up that lacked any finesse, and was lucky to play anything past 5 kHz. It would have been lucky if the records contained information much higher than this anyway. No FM remember, only AM. Why did Voigt make such joy that his speaker had good output past 13,000? What *was* the point?

It is easy to forget that AM radio is capable of a very high quality of sound reproduction. These days, with stations limited to an 8 kHz bandwidth and crammed on your radio's dial like sardines in a tin, AM is not even lo-fi , it's no-fi.

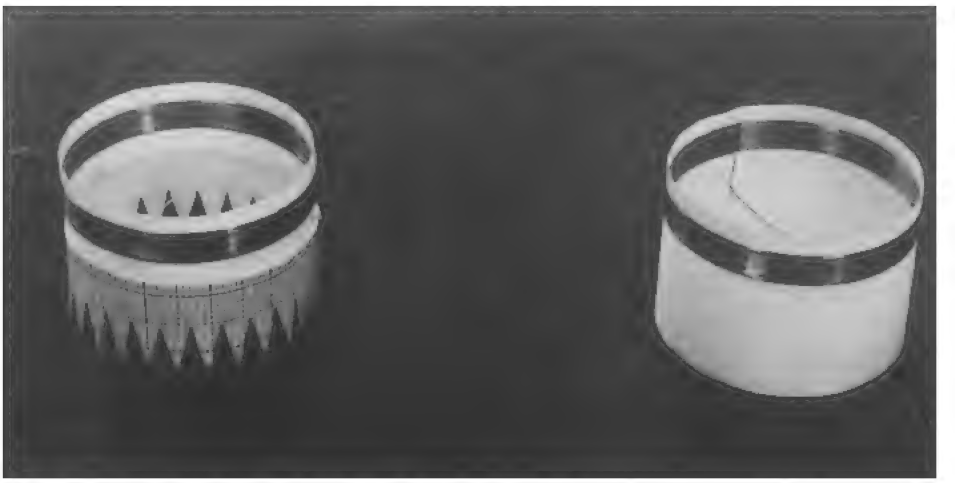
Sixty years ago the waves were not as crowded. A radio station could take up as much bandwidth as it was capable of. Microphones of quality were around, as were electronics capable of decent bandwidth. Imagine our illustrious radio listener circa 1935. He could tune into one of the BBC's live concerts, free from any kind of processing (practically none existed), straight to the transmitter, and onto an empty radio band, virtually free from interference.

In the home, genuine "radiophiles" would have nothing other than a "straight set" (or TRF, if you prefer). These receivers had massive bandwidth giving good frequency response, and no superheterodyne whistle to hide. Sensitivity was down to the amount of aerial you had up. The most complicated straight sets consist of two stages of R.F. amplification and "diode" to remove the sound wave from the RF carrier wave. Amplification via a couple of PX4 triodes, push pull class A, all driving the Corner Horn. I can imagine the whole thing being quite awesome.

I once built (sort of as a joke) a wide bandwidth AM tuner (TRF of course) and matching transmitter. I was amazed at how good the medium actually was. Perhaps we all took to FM a little too early. At any rate, the early quest for great radio sound was where what later came to be known as Hi-Fi has its roots.

Lowther through the Hi-Fi Years

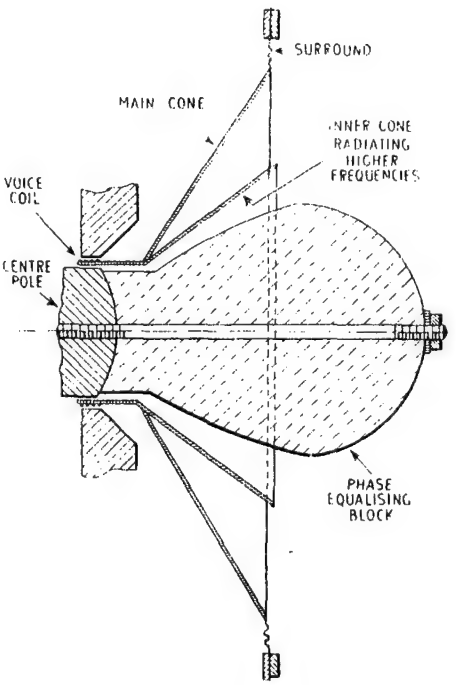
Voigt left England soon after the end of WWII hostilities, bad health meant he had to go to the warmer climate of the North Americas. His designs were left in the capable hands of Lowther, and particularly Mr. Donald Chave, although Mr. Mordant, later of Mordant Loudspeakers, also played a very important role.



Dual wound voice coil - Aluminum for low weight

The original Voigt Corner Horn was carried back into production virtually unchanged after the war. Voigt and Chave, working independently, introduced the first *permanent magnet* drive units in the late 1940s.

Chave's PM-1 unit brought about a small improvement in gap flux, and dispensed with the need for 200 volts DC. The PM2 followed, and around the same time Voigt's original spider disappeared, to be replaced with a more modern type. This switch allowed Chave to fit a "phase plug" in the centre of the voice coil, to prevent the very high frequencies from cancelling themselves out in the apex of the cone, thereby extending the frequency response from the previous 13,000 to past 18,000 Hz.



Cross-section of Lowther-Voigt driver

The PM3 was the next drive unit to be offered. This was a custom drive unit for the TP1 enclosure, which offered a front mounted Tractrix horn on the front of the units and an exponential horn for the bass. As with the early corner horns, the TP1 must be used in a corner.

An update of the Voigt Corner Horn, the PW2 followed. It was fitted with the new "baby" PM6 unit, which despite its magnet's physical size, had an in-gap flux higher than the PM1 it effectively replaced. The PW2 was not as good as the original Voight Corner Horn but it was far cheaper.

Later drive units are the PM2 mkII (Lowther's biggest magnet), PM2 mkIII (essentially a mkI with a different mounting bracket), PM4 (a PM2mkII with cobalt pole pieces) and last of the line, the PM7, which despite its smaller size I think is a better unit than the bigger PM2, and much easier to use.

All these units share the same basic cone/chassis. PM2s and the PM4 have a magnet support frame, the original chassis cannot support the full weight of the magnet. The PM3 looks like it is mounted in a saucepan!

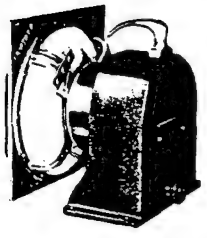
There are two options on phase plugs, one is a small beastie that is used in cabinets where the front of the unit is not coupled to a horn, the larger item is for a unit coupled via a horn.

LOWTHER *Drive Units*



PM 2 Mk. 1.
Gap flux 21,000 gauss. Total flux 281,000 maxwells. Frequency range 20-22,000 Hz. Impedence 15 ohms. Capacity 6 watts. Weight 6 kilos.

PM 5
Size and details as PM2 Mk. 1 BUT with 23,200 gap flux.



PM 2 Mk. II
Gap flux 23,000 gauss Total flux 350,000 maxwells. Frequency range 20-22,000 Hz. Impedence 15 ohms. Capacity 6 watts. Weight 8 kilos.



PM 6
Gap flux 17,500 gauss. Total flux 196,000 maxwells. Frequency range 20-22,000 Hz. Impedence 15 ohms. Capacity 6 watts. Weight 3 kilos.

The special design of the PM 6 drive unit preserves the fundamental to harmonic relationship throughout the entire audio range, thereby ensuring smooth, natural sound. Designed especially to meet the requirements of horn-loaded operation, the PM 6 should never be used as a conventional direct radiator.

PM 6 Mk. I is a PM 6 magnet assembly with a new diaphragm assembly: LOWTHER SPECIAL SILVER speech coil, roll surround and back centering providing an improved performance.



PM 3 (Not available as a separate unit from TP 1 enclosure.)
Gap flux 21,000 gauss.
Total flux 281,000 maxwells.
Frequency range 20-22,000 Hz.
Impedence 15 ohms.
Capacity 6 watts.
Weight 10 kilos.

PM 3/5
This improved PM 3 unit has a gap flux of 23,200 gauss.



PM 4
Gap flux 24,000 gauss.
Total flux 385,000 maxwells.
Frequency range 20-24,000 Hz.
Impedence 15 ohms.
Capacity 6 watts.
Weight 8 kilos.
PM 4 drivers are fitted with special cobalt alloy pole pieces.



PM 7
Gap flux 19,650 gauss.
Total flux 250,000 maxwells.
Frequency range 20-20,000 Hz.
Impedence 15 ohms.
Capacity 6 watts
Weight 4 kilos.

Representative Lowther lineup from late '60s through early '70s

Lowther's mainstay cabinet range during the 1960s was called the Acousta line. Originally in two forms, an odd looking corner thing, that fired the unit into the room's corner, and a much better model, with the unit and mouth of the horn pointing at you. Most Lowther cabinets were now fitted with constant width rear horn, the exceptions being TP1, Audiovector and the L.I.B. (Lowther Ideal Baffle, which used a "drone cone").

Chave constantly updated the designs. The small Corner Acousta became the Dual Position Acousta, and the standard Acousta was updated to suit the PM6 and PM7 units.

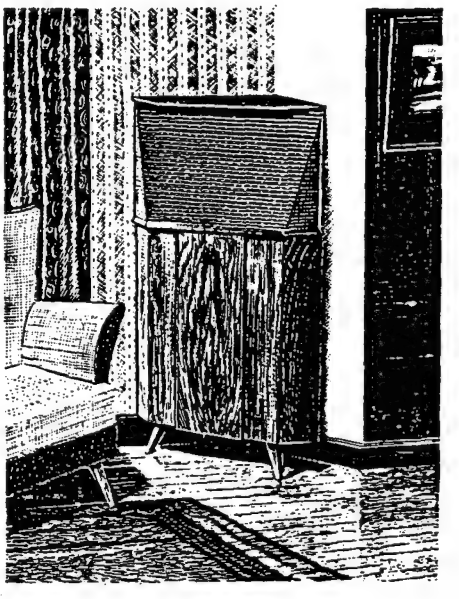
Throughout the 1970s countless different variations on the Acousta theme appeared. Mini Acoustas, Super Acoustas, Twin Acoustas — you get the picture. Cabinet material changed from ply to MDF. In my humble opinion, this was a BIG mistake. Chave should have listened to Voigt's then thirty year old ideas.

Lowther Today

Later in the early '80s, Lowther were the last to switch over to ceramic magnets from the alnico/ticonal they had previously used, although thankfully they still manufacture the original superior units. The current owners of Lowther are convinced ceramics are much better than the alnicos. You can guess what I think.

The current line includes several models using the "BICOR" principle, wherein two different sized horns are fitted to one cabinet. I make no bones about not liking one bit of these designs, although others swear by them.

In recent times, the design of the basket has been improved to some extent. Over the years, there were four generations of Lowther-Voigt drive units: early mains energized electromagnetic units, the mainstay of the '50s through the early '70s one piece alloy cast chassis, to the latest "black" chassis. During the '70s some production was fitted with a plastic basket.



Corner housing Type P.W.2, Walnut Finish.

Build the 1964 Acoustas

The design we are presenting here in *Sound Practices* is the 1964 version of the full size Acousta. This model will work happily with PM6A, PM7A, or if you are on a tight budget, the PM6C. It is a pretty self explanatory blueprint, an' I am no great woodworker, but I would offer these few tips:

Always build a folded horn from the best grade of ply you can afford. NEVER use MDF. When assembling the cabinet make sure you sand all of the internal joints so they are s-m-o-o-t-h, this is especially important near the "neck" of the horn. If you have rough patches, the bass horn loses its efficiency. Worse still, if it is rough near the neck, soundwaves reflect back through the cone and give the sound a "dirty" complexion.

PM6 ceramics have three problems not associated with their Alnico brothers. First the large ceramic puck reflects sound from the rear of the cone back towards it, the alnico version has carefully shaped magnets to avoid this problem. Unfortunately, it would be impossible to duplicate it in ceramic.

Due to this magnet shape, to use the ceramic speaker you must make a "gasket" of 1/4" ply, because there ain't no way that big ceramic baby is gonna fit in the li'l magnet box given in the 1964 plans.

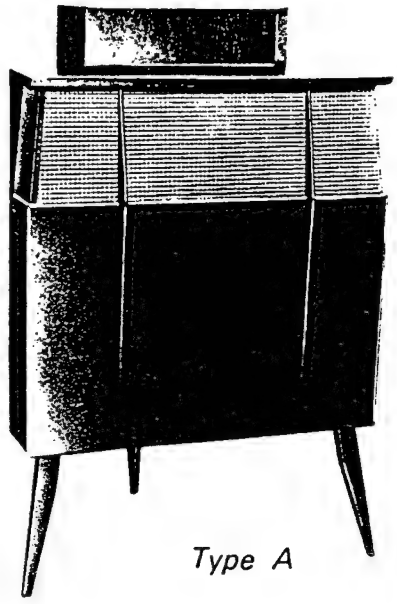
Final problem with the PM6C is more serious and a touch bizarre. For some strange and unexplained reason, Lowther fit a cone to the ceramics which is embossed with an annular pattern. I call this cone the "ribbed for extra sensation", I suppose it is whatever takes your fancy. I can see what they are trying to do, they are trying to stop "bell mode" cone breakup. Problem is, it does not help the other cone breakup mode, the "concentric" mode. The originals have a much better idea. "Diagonal" patterns are deeply embossed into the paper cone. This helps stop both "concentric" and "bell" modes of cone breakup from occurring.

At the end of the day I must conclude that unless you are totally and utterly strapped for cash, go for a pair of PM6 or PM7 alnicos. 'Tis the best, no doubt.

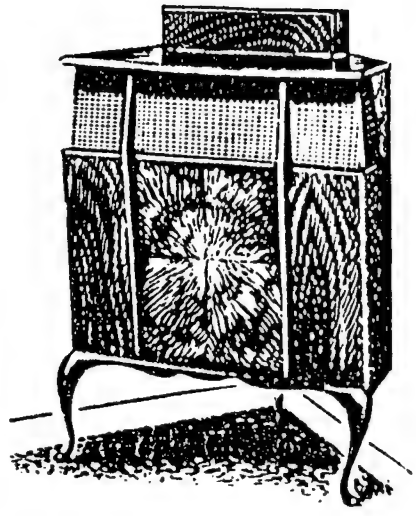
Sound wise all three magnet options kick ass. Even the "ribbed for extra sensation" PM6C sounds good. I use a pair of carefully made Acousta fitted with PM7A drivers.

LOWTHER

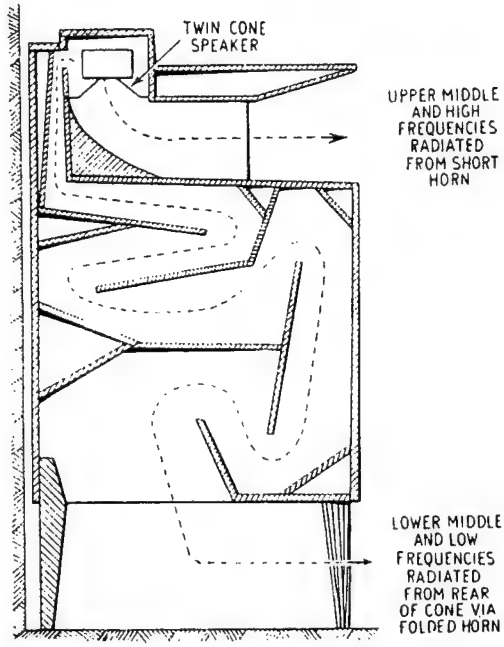
CORNER REPRODUCERS MODEL T.P.1

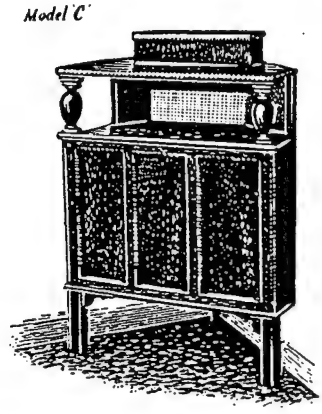


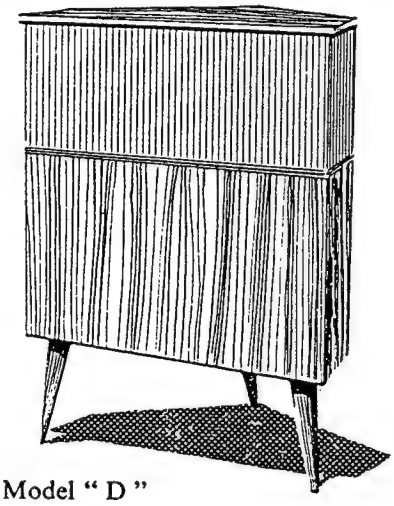
Type A



TYPE B







Model " D "

MODERN LOWTHER DRIVERS

ABRIDGED SPECIFICATIONS Specifications abregées Kurz Spezifikationen	PM6A	PM7A	PM2A	PM5	PM4
Overall Diameter Diamètre hors tout Gesamt – Ø	23.2cm	23.2cm	23.2cm	23.2cm	23.2cm
Overall depth Epaisseur hors tout Gesamttiefe	10.5cm	11.0cm	13.0cm	13.0cm	15.5cm
PCD Mounting Centres Ø de cercle primitif de centres de montage Teilkeis–Ø D.Befestigungspunkte	20.8cm	20.8cm	20.8cm	20.8cm	20.8cm
Baffle hole cut-out Ouverture du baffle Schallwandöffungs – Ø	19cm	19cm	19cm	19cm	19cm
Voice coil diameter Diamètre de la bobine mobile Schwingspulen-Ø	3.9cm	3.9cm	3.9cm	3.9cm	3.9cm
Voice coil impedance (nominal) Impédance de la bobine mobile Schwingspulenimpedanz	8or15ohm	8or15ohm	8or15ohm	8or15ohm	8or15ohm
Air gap width Entrefer Luftspalt	1mm	1mm	1mm	1mm	1mm
Magnet type Type d'aimant Magnettype	Alcomax2	Alcomax3	Alcomax3	Alcomax3	Alcomax3
Flux Density (1 Tesla = 10,000 Gauss) Densité du flux Kraftliniendichte	1.75Tesla	1.95Tesla	2.1 Tesla	2.3Tesla	2.4Tesla
Diaphragm Diaphragme Membran	Twin-paper Double/papier Doppelmembran/pappe				
Frequency response Réponse de fréquence Übertragungsbereich	30Hz-20kHz	30Hz-20kHz	30Hz-22kHz	30Hz-22kHz	30Hz-22kHz
Nominal air resonance Résonance nominal à l'air libre Nennresonazwert in freier Luft	36Hz	36Hz	36Hz	36Hz	36Hz
Sensitivity at 1m/1kHz/1Watt Sensibilité 0.2MN/m^2 Ansprechempfindlichkeit 0.2MN/m^2	96db	96db	97db	98db	98db
Maximum voice coil travel Déplacement de la bobine mobile Schwinspulenweg	±1mm	±1mm	±1mm	±1mm	±1mm
Shipping weight Poids d'expédition Versandgewicht	4.0kg	4.0kg	6.0kg	6.5kg	10.0kg

ABRIDGED SPECIFICATIONS Specifications abregées Kurz Spezifikationen	45C	55C	PM6C	PM7C	PM2C
Overall Diameter Diamètre hors tout Gesamt – Ø	17.4 cm	17.4cm	23.2cm	23.2cm	23.2cm
Overall depth Epaisseur hors tout Gesamttiefe	5.6cm	5.8cm	7.6cm	7.6cm	7.8cm
PCD Mounting Centres Ø de cercle primitif de centres de montage Teilkeis–Ø D.Befestigungspunkte	15.6cm	15.6cm	20.8cm	20.8cm	20.8cm
Baffle hole cut-out Ouverture du baffle Schallwandöffungs – Ø	14cm	14cm	19cm	19cm	19cm
Voice coil diameter Diamètre de la bobine mobile Schwingspulen-Ø	3.9cm	3.9cm	3.9cm	3.9cm	3.9cm
Voice coil impedance (nominal) Impédance de la bobine mobile Schwingspulenimpedanz	8ohm	8ohm	8ohm	8ohm	8ohm
Air gap width Entrefer Luftspalt	1mm	1mm	1mm	1mm	1mm
Magnet type Type d'aimant Magnettype	Feroba 2	Feroba 2	Feroba 2	Feroba 2	Feroba 2
Flux Density (1 Tesla = 10,000 Gauss) Densité du flux Kraftliniendichte	1.75Tesla	1.98Tesla	1.75Tesla	1.98Tesla	2.1 Tesla
Diaphragm Diaphragme Membran	Twin-paper Double/papier Doppelmembran/pappe				
Frequency response Réponse de fréquence Übertragungsbereich	80Hz-20kHz	80Hz-22kHz	30Hz-20kHz	30Hz-20kHz	30Hz-20kHz
Nominal air resonance Résonance nominal à l'air libre Nennresonazwert in freier Luft	60Hz	80Hz	36Hz	36Hz	36Hz
Sensitivity at 1m/1kHz/1Watt Sensibilité 0.2MN/m^2 Ansprechempfindlichkeit 0.2MN/m^2	93db	94db	95db	96db	97db
Maximum voice coil travel Déplacement de la bobine mobile Schwinspulenweg	±1mm	±1mm	±1mm	±1mm	±1mm
Shipping weight Poids d'expédition Versandgewicht	2.5kg	3.0kg	3.0kg	3.5kg	4.0kg

They are totally compelling. The stronger the magnet, the more high frequencies you get. The '6C has a pleasant, almost "soft" sound compared to the more expensive Alnico versions. If you are having hum problems with your setup, the '6C might be the one to go for due to its lower (97 dB) sensitivity. Overall, the '6C is very easy on the ear.

By way of improvement, the Alnico PM6A gives an extra 3 dB sensitivity and a "cleaner" presentation. With the Cs you are aware you are listening to Hi-Fi, but the '6As just disappear, leaving only the music behind. The music seems to come from nowhere.

The PM7s go all the way. It is amazing how much extra detail these babies can pull out of the signal. The PM7 is even higher sensitivity (102 dB/1W), cleaner, sharper, and more focused. If these drive units were cameras, the 6C would be a Leica miniature, the 6A a Bronica, and the 7A without doubt a Hasselblad.

If you have carefully constructed the cabinet, you should have very little coloration, and by the time you have "tuned in" (this process usually takes five minutes) you will not notice any.



Acousta cabinet fitted with PM7A

At first audition, the Acoustas will seem odd. The bass will appear thin, the treble will lack sparkle, but the sound will grab your attention. All of a sudden, a real bass note will come along—BANG you are blown out of your chair by a pair of 6" woofers. A cymbal is brushed and then tapped, at last you can hear the difference. No more phasey ting or engineered bass bloom, everything very natural.

I guarantee you have not experienced anything as dynamic and true to life as this speaker, regardless of your choice of drive units. A 1 watt per channel amp will make your ears bleed (unless you are in a very large room, and then you may have to insist on at least a 2A3 SE).

The Acoustas are so "correct" you will find everything else "odd". If you try to switch back to your TING-BOOM speakers, you now will hear real coloration, and you won't like it.

Be careful to sit on axis with the Acoustas, off axis the sound takes on a woody coloration. The HF is very directional. Sometimes moving your head an inch can cause the highs to do a disappearing act.

My fave Lowther design is the classic TP-1. This speaker is the best. There is a school of thought in audio that if something is buttugly, it must work well. The TP-1 is the most odd looking piece of woodwork I have ever clapped eyes on. Whoever decided to fit this thing with Regency style Queen Anne legs must have had a sense of humor. The damn thing looks alive in the corner of the room, almost like some strange robot from a B movie.

But the sound . . . the front horn gives them more presence and less "spotlight" treble than the smaller Acoustas. The bass is just awesome. Even heavy rock fans will love the TP-1.

Given the choice of either a pair of Tannoy 15" silvers/Lancaster cabinets or Quad ESLs against the Acoustas or TP-1s, Lowther wins hands down. It is far more natural, more lifelike, more "you are there", less from a box, less from a pile o' tubes, capacitors and resistors.

If sourcing drive units second hand, be careful. Lowther were one of the first to go to foam surrounds, which have usually rotted by now. Lowther-Voigt in the UK will repair them, but at a high price. NEVER use a Lowther with any transistor amp that comes on with a thud! Any amount of DC through the coil will see the inner voice coil fall off the former, with disastrous and expensive results.

The gap between pole pieces in the Lowther drivers is very small compared with most designs. This helps to saturate the voice coil in magnetism. The PM4A is the only speaker made that has a totally saturated voice coil gap. 24,000 gauss! Nothing comes close.

Even a lowly PM6C has a good magnet to cone mass ratio. It has to in order to get the high frequencies. If a PM4 were a car, it would have a power to weight ratio of 1,000,000 BHP per ton!

It is interesting to note that mechanically the units cross over twice. Very high frequencies come directly off the edge of the inner voice coil (hence the need for a phase plug), the next frequencies down are handled by the "whizzer" cone, and finally the 6" cone.



When buying vintage Lowther drivers, watch that foam!

Nothing is ever perfect, on a swept frequency response the Lowthers do themselves no favours (especially the PM6A, which has a curious peak at 11 kHz, adding a bit of false presence). But on a pulse test, they are in the electrostatic class.

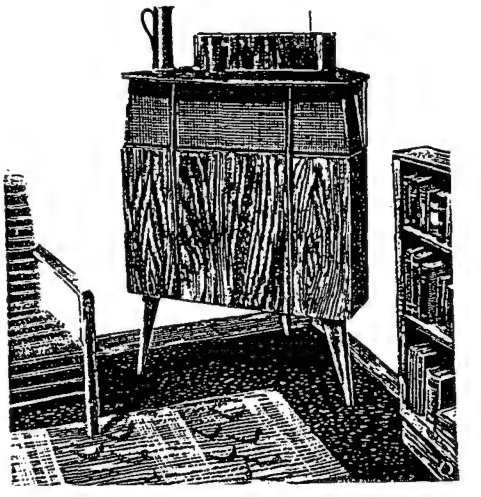
If you overload them they damage very quickly, a small SE or small PP amp is *de rigeur*. When forced to handle 15 watts, you can make the voice coil fry. Just remember that 15 watts in a Lowther is in excess of 111dB! That is painful. Most owners will NEVER use any more than 1,000 milliwatts of power.

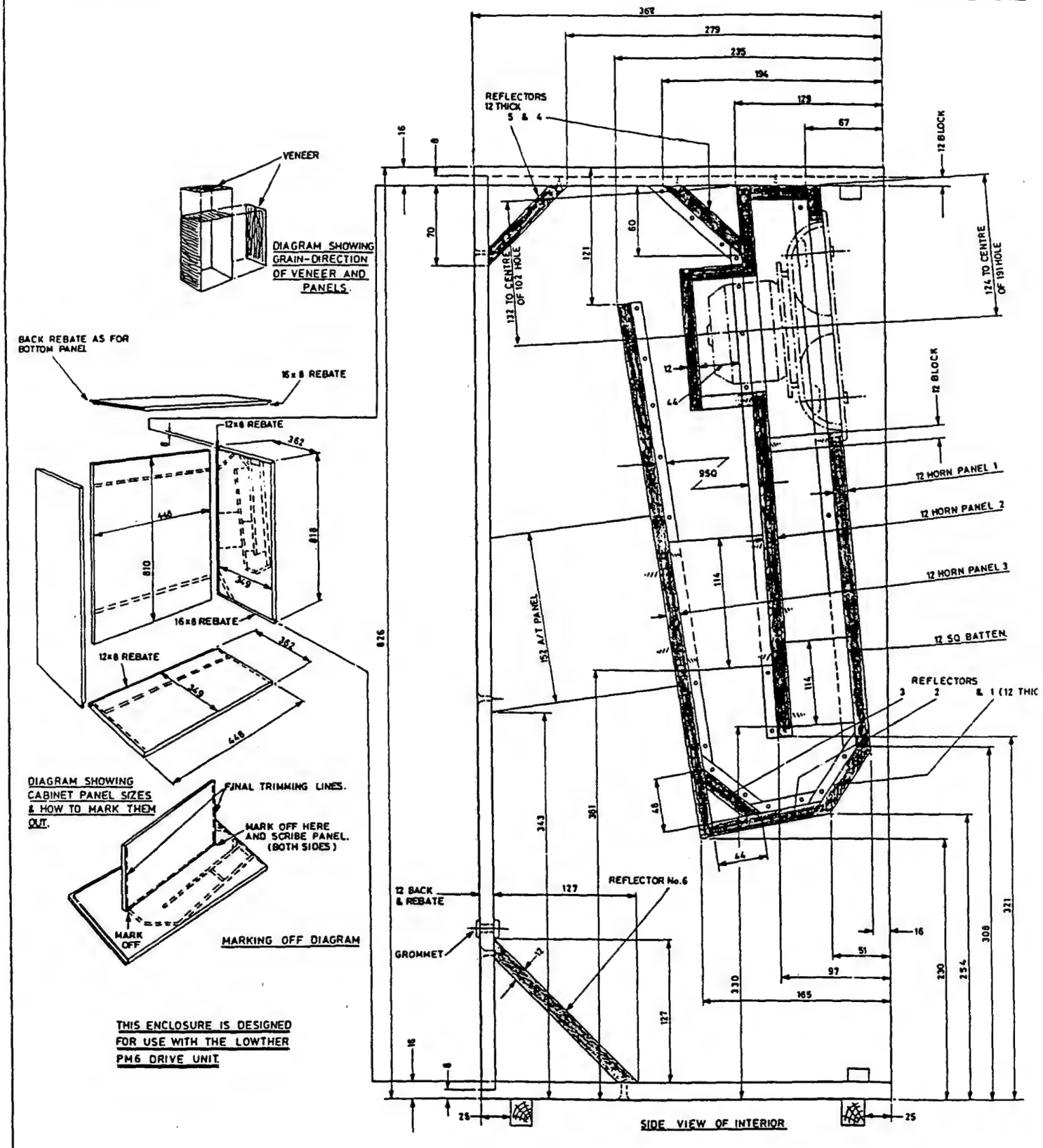
Prices of Lowther drive units vary from £250 for PM6C up to £900 for a pair of PM4A. Second-hand prices vary wildly from country to country—just watch that foam on vintage units.

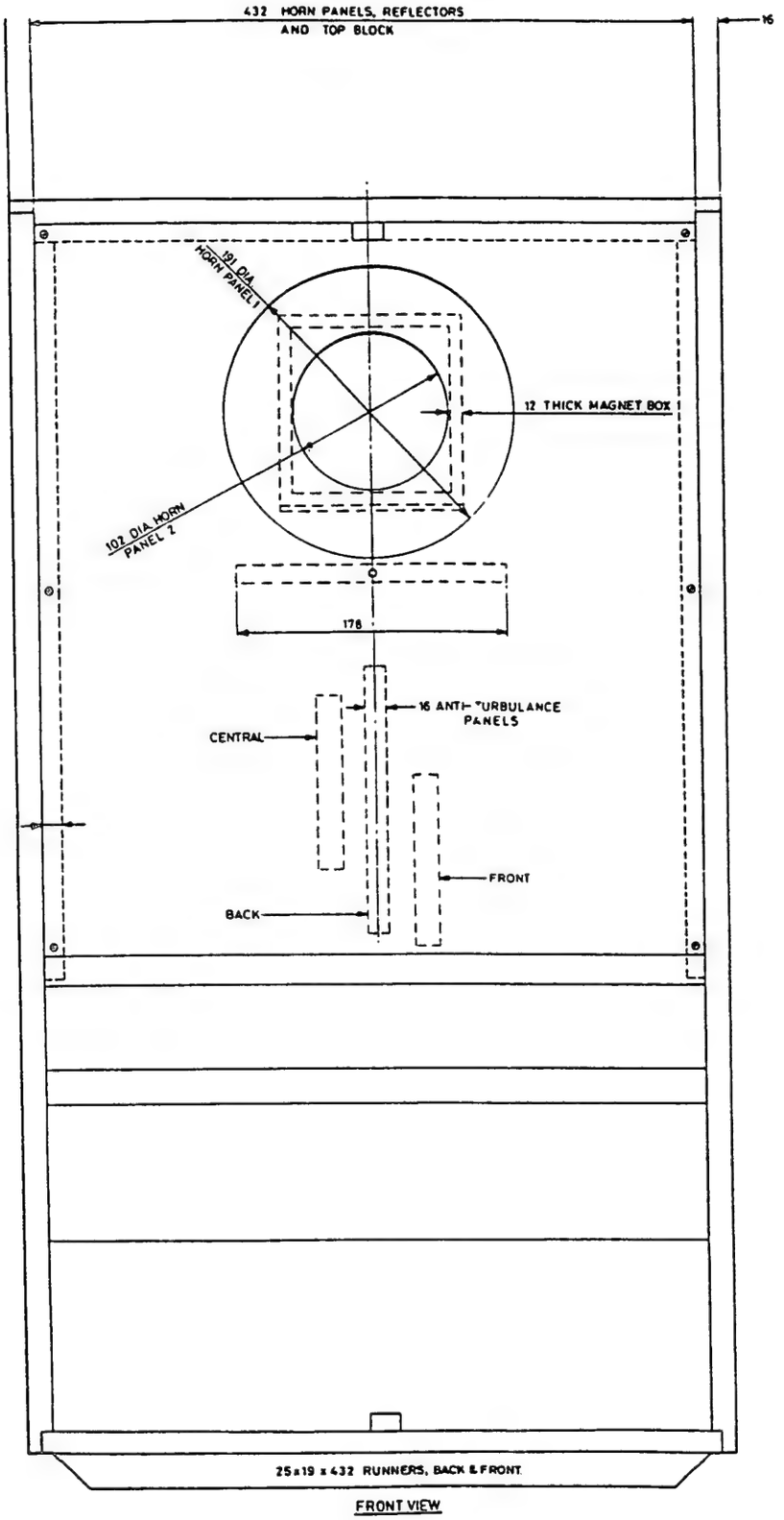
TP1 and Audiovector cabinets fetch very high prices, justifiably so. In my estimation, Lowther can offer no new complete loudspeaker to match these underrated classics.

I get the feeling that the factory considers the old top of the line cabinets somewhat old fashioned and dumb, but they sound as good today as they ever did. The TP-1 is certainly not an amateur woodworking project but if you have the skill and the plans, go for it. If you happen to have the plans for the original TP-1, *pleeeze* send me a copy care of SP, so I can get myself a pair.

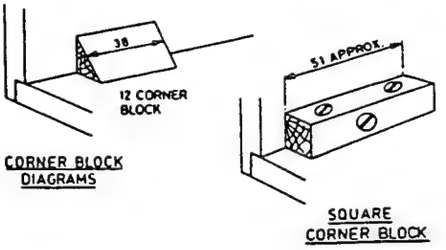
Perhaps price has something to do with it. In 1962, a Tannoy 15" dual concentric cost £37 10s, while a Lowther PM4 cost £48! The price of TP-1A was just under £200 a pair. For what you're getting for your money, I consider the present selling price of Lowther drivers to be far too cheap. Buy yours now before they realize and shove the price up!




VENEER
DIAGRAM SHOWING GRAIN-DIRECTION OF VENEER AND PANELS.
BACK REBATE AS FOR BOTTOM PANEL
16 x 8 REBATE
12x8 REBATE
362
448
810
818
349
16x8 REBATE
12x8 REBATE
362
349
448
DIAGRAM SHOWING CABINET PANEL SIZES & HOW TO MARK THEM OUT.
FINAL TRIMMING LINES.
MARK OFF HERE AND SCRIBE PANEL. (BOTH SIDES)
MARK OFF
MARKING OFF DIAGRAM
THIS ENCLOSURE IS DESIGNED FOR USE WITH THE LOWTHER PM6 DRIVE UNIT
REFLECTORS 12 THICK 5 & 4
367
279
235
194
129
67
12 BLOCK
16
8
70
121
60
132 TO CENTRE OF 102 HOLE
124 TO CENTRE OF 191 HOLE
12
44
12 BLOCK
950
12 HORN PANEL 1
12 HORN PANEL 2
12 HORN PANEL 3
12 SQ BATTEN
153 A/T PANEL
114
114
826
REFLECTORS
3
2
& 1 (12 THIC
48
343
391
44
12 BACK & REBATE
127
REFLECTOR No.6
GROMMET
12
127
16
51
97
165
330
230
254
309
321
16
8
25
25
SIDE VIEW OF INTERIOR



FRONT VIEW



CORNER BLOCK DIAGRAMS

SQUARE CORNER BLOCK

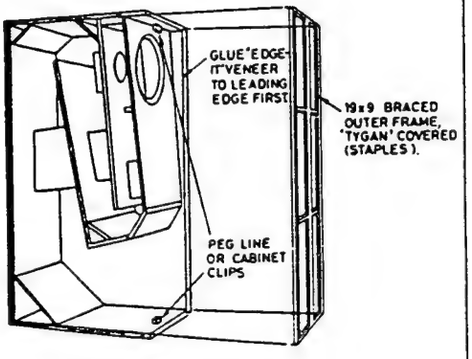


DIAGRAM OF INTERIOR

CUTTING LIST

DESCRIPTION	SIZE	No OFF	DESCRIPTION	SIZE	No OFF
16 BLOCKBOARD *			REFLECTOR 1	86 x 432	1
SIDE PANELS	826 x 362	2	" 2	98 x 432	1
TOP PANEL	464 x 362	1	" 3	67 x 432	1
BOTTOM PANEL	451 x 362	1	" 4	95 x 432	1
12 BLOCKBOARD			" 5	98 x 432	1
BACK PANEL	821 x 451	1	" 6	178 x 432	1
HORN PANEL 3	478 x 432	1	BATTENS	1250x495	2
HORN PANEL 2	491 x 432	1	"	950x432	2
HORN PANEL 1	503 x 432	1	"	950x407	2
MAGNET BOX	127 x 127	1	"	950x 73	2
" "	127 x 51	2	"	950x 70	2
" "	102 x 51	2	"	950x 60	2
HORN PANEL SPACERS	56 x 432	1	"	950x 70	2
" "	52 x 178	1	RUNNERS	25 x 19 x 432	2
A/T PANEL	152 x 165	1	BRACED FRAME	19 x 9 x 4108	1
" "	114 x 90	1			
" "	114 54	1			

*OR GOOD QUALITY CHIPBOARD.

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ISSUE	DATE	MODIFICATION
A	16.9.99	REDRAWN DRAWING ORIGINALLY QUARTER FULL SIZE NOW HALF SCALE AND DRAWING CONVERTED TO MILLIMETRE DIMENSIONS.

ITEM No.	DESCRIPTION	No OFF	DRG. No.	MATERIAL	REMARKS
	THE LOWTHER ACOUSTA 115 ENCLOSURE				

LOWTHER ONLIFE DEVELOPMENT LTD.
BROMLEY, KENT,
ENGLAND

DRG.	CHKD	APPD
D.D.P.	D.D.P.	

SCALE: AS SPECIFIED

DRG No. 651 SHT 1

Join the Club!

by Joe Roberts



Like all 20th Century American youth, I was brought up to believe in the inevitability of progress. Over time, I realized that some very worthy concepts and tools disappeared in the marketplace scramble over the decades. You can find good stuff under all those Kraco 8 track players, LED wristwatches, IBM Selectric typewriters, blown out Phase Linear amplifiers, 6 V tube car radios, and Commodore 64 computers down at the town dump. Might even unearth a few directly heated triodes if you dig deep enough.

Some observers call the current interest in vacuum tube technology *retro* audio, as if to say "aha, *nostalgia* buffs". True that some of us are history students, but most are just looking for some good tunes in 1995, don't know anything about all that old junk, and often couldn't care less. People who are listening to triode amps proudly consider themselves to be *futurists* not retro geeks. Triode listeners are not living in the past.

And why should they want to? There is a lot going on in the audio universe right here in 1995. In particular, the tube scene is healthier than it has been for decades, maybe since the rise of the transistor. There is no longer any need to be an antique hound if you're into hollow state. You can build an amp out of triodes and fancy output transformers that came out only this year if you really want to be *au courant* and whatnot.

After fifteen years of push-pull parallel 6550 amps, audio was certainly ready to take the next step. I admit that reproducing music is an astoundingly difficult feat, but we weren't even getting *close* with most of the fake rackmount tube amps of the high-end era. Who's fooling who?

Okay, so maybe we haven't come *that* far since 1992, but at least there's real excitement in the air for a change. People who have been in audio all their lives feel like they're really getting somewhere bringing music home, often just when they were on the verge of giving up the quest, selling the Gold Lion KT-88s in the safe deposit box, and investing the proceeds in a remote control home theater setup.

Perhaps after all the hype and love at first sight about triode amplifiers evaporates and we have a chance to absorb what we're hearing, maybe it will turn out that we really *are* learning something important about music reproduction in the flux and confusion of the present moment. Maybe in a few years we'll really learn how to use tubes to play music. Hope springs eternal.

What people are calling *retro*, I call refusing to let a good idea die. A good idea is one we can still learn something from, regardless of vintage. We sure can't go home to the Thirties after twenty years of reading *TAS* and *Stereophile*. Just because you use a few classic parts and techniques out of Lee de Forest's attic doesn't mean you're a time traveler. We're headed into the future on a one way track. Ain't no going back.

Yesterday's brilliant solutions become quaint curiosities when they no longer answer the questions that are being asked. New goals and changing technological contexts leave two year old hi-tech wunder products sitting by the curb on trash night. Obsolescence often doesn't have anything to do with user satisfaction or what a user would consider quality. It's usually a business decision, based on cold numbers alone.

Freedom of choice for the mass consumer ultimately boils down to freedom to choose from whatever they're trying to sell you at any given point in time. You can only eat what is on the menu — unless, of course, you're willing to cook for yourself.

Today we're experiencing a refreshing initiative among audio people to create our own idiosyncratic niche of electronics, based on the best of the past, present, and future. We're moving beyond obsolescence, nostalgia, and the tunnel vision of the mainstream. The synthesis of hindsight and forward thinking we're seeing today is a sign of maturity, experience, and an emergent late 20th c. pragmatism toward our past audio achievements and future audio goals. This surely isn't retro, it never happened before.

ALIVE AND KICKING

The Lowther-Voigt story is one of the great sagas of 20th century audio technology. Their mainstay product, Paul Voigt's twin cone full-range loudspeaker, has been in continuous production, with refinements and changes, for almost *fifty* years. Today's high tech doesn't last fifty weeks.

No doubt Lowther ran into hard times during the transistor muscle amp era when an ultra high efficiency, limited power handling dainty thing like a Lowther was considered a peculiar prehistoric artifact. Who needs 100 dB efficiency with half kilowatt amps? The merest touch of DC offset on the output of your Ampzilla and your dual-wound Lowther voice coils transform into a puff of expensive grey smoke. Down at the audiophile society, the whizzer cone alone is enough to provoke fits of laughter.

But those who understood the product weren't laughing. Lowther has always enjoyed a very dedicated following and many stayed with the company through the dark ages of the high-powered high-end. This core of Lowther devotees together with determined management kept the company going over the past few dry decades.

Apparently, sales have been on the upswing in recent years with the resurgence of general interest in tube amplification and low power tubes in particular. Lowther currently has a tube amplifier and matching preamp in the works. They are actively expanding their world distribution network. Business is good in the Asian audiomania market, where locals have taken a liking to Lowthers. Like I was saying, it's hard to keep a good idea down. For Lowther, maybe it was just a question of sticking around until the world caught up with them again.

ONE WAY OUT

The appeal of an uncompromising one-way speaker like the Lowther is obvious. No other approach maintains the fundamental wholeness of the signal. *All* crossovers segment the analog continuum. In the minds of some holistic purists, this is an unnatural thing to be avoided. It's like having one instrument playing the fundamental and another playing the harmonics.

A similar line of argument is often levied at digital. Why take something apart that is whole to begin with and needs to be whole at the output? Can we really take it apart expertly enough to put it back together again properly? It is a strange idea to break up music into constituent parts with electronics then reassemble it, but we do it all the time without thinking about it.

The glaring drawback with full-range cones is that in most instances they are not *really* full range according to industry standards. Typically a big chunk of the low end is missing and anything above 13-15K is gone. There is no reason to accept that kind of bandwidth limitation in even the most unambitious systems if you're willing to use more than one driver. A $3 tweeter can get you out to 22 kHz. On the other hand, getting a single driver to play 40-20K full range is a wildly ambitious engineering effort. What? Much more work? Way higher cost? Same specs? Pass the tweeters.

The challenge and art of the traditional full-range cone, or any kind of speaker, is balance. In short, if you don't have an extended low end, you can't have an extended top end or the sound will be thin. The LF and HF rolloffs must be complementary. If you put a tweeter or woofer on a full range cone, or use loading tricks to extend bandwidth on the low end, you can ruin it. Limited range can sound very satisfying but it has to be limited at the right points. A mini monitor that only goes down to 70 Hz with the wind blowing in the right direction should be bandwidth limited up top also. 70-30K doesn't work as well as 70-13K.

The Lowther drivers escape this conundrum, since they are *truly full range* devices when appropriately installed. Given that they are intended to be rear horn loaded for the low end, yielding a bass efficiency boost, the high end output is adjusted accordingly. For this reason, you can't just put a Lowther in a bass reflex or on a flat baffle. The price you pay for Lowther-style full-range one way sound is complexity in box design and a hefty bill from your cabinetmaker.



Homespun Opus One cabinet in progress in Lowther enthusiast Frank Reps' workshop. Frank says that since he's been into triode amps, the QUAD ESL-63s live in the closet and the TP-1s are in the listening room making sweet music with his Audio Note Ongaku doing the honors.

It sure would be nice if mechanical simplicity came along with the conceptual simplicity of the single full-range driver, but that's not the way the universe works. Achieving the bandwidth which the Lowther speakers provide in a one-way design takes heavy engineering and careful execution.

The Lowther magnets are incredible, especially on the upstream models. Enthusiast Frank Reps took an old PM6A he was restoring over to a super high tech magnetizing laboratory out in California and they couldn't re-magnetize the unit to factory specs. This feat requires very special and precise Lowther factory procedures. All that magnetic flux is provided to move the cone through a total excursion of 1 mm!

The Lowther drivers have always been hand made and the end result of that fine British craftsmanship comes out looking like a dainty flower with a huge chunk of magnet where the stem should be. At first glance you know that there is nothing else like a Lowther. And it sounds like it looks.

Living with Lowthers is an adventure that benefits from a thoughtful appreciation of and a close personal relationship with the technology at hand. Hartmut said it all in a message on the Internet:

> "If anything ever is or was the Bugatti of something then the Lowther drivers are the Bugattis of speakers. In all respects, mind you . . . and not disregarding the Bugatti Owner's Manual suggestion for starting a Bugatti on what the Bugatti might consider a cold day — nothing complicated, just tap off all the oil and heat it gently on a stove to some recommended temperature . . . and then follow all the other simple instructions and in the end your Bugatti will start if it feels like it."

If you go around asking about Lowthers you'll hear tales like this, but the thing is that usually they come from the lips of people who LOVE Lowthers and wouldn't listen to anything else. Lowther owners enjoy telling war stories but look at where their hearts are. Basically the Lowthers are instruments requiring intelligence and care in use. They'll last for many years if treated well but they're not bulletproof by any stretch.

With such a hyper-strong magnet and a ultra-slim magnetic gap, the danger of some sliver of ferrous junk getting in there and interfering with voice coil movement is something to worry about. Best to work with the naked drivers in a clean environment, not on a dirty garage floor or junk-strewn workbench. Keep the drivers in plastic bags when not safely installed in a cabinet. Old timers suggest protecting the front of the driver by stretching a nylon stocking across the cone after installation as a dust cover.

Might also want to slip off your automatic Rolex before handling your PM4s and keep a strong grip on the screwdriver during installation. The magnets on Lowthers are wickedly powerful and recone kits ain't free.

Lowther was the first manufacturer to use foam surrounds. The dreadful foam on most of the early foamed speakers is crunchy brown dust by now. The new foam is much more durable and long lasting but the ancient jokes about Lowther foam persist. You can still get cone kits, so any disaster short of theft is repairable.

Some Lowther aficionados insist that the cones take a few *years* to break in, and the older they are the better they sound. The paper Lowther cone is indeed almost a living thing. I listen to a pair of PM6As in my Edgarhorns off and on and I know what they mean about sensitive. Changes in humidity trigger sonic changes. Nothing sounds better on a rainy day than a Lowther, not a problem in England, I'm sure.

Beyond the routine care and feeding issues involved in keeping a British hotrod like the Lowther on the road, a bottomless tradition of tweakery grew up around them over the years. Every substance known to man has been smeared on a Lowther cone at some point in time. Start cataloging some of the crazy cabinets designs that Lowther fans have been spinning since the 1930s and you'll realize that you struck one of the main veins of hi-fi tweakery. Five whole issues of SP dedicated entirely to Lowther wouldn't even scratch the surface.

In short, the Lowther is a pure enthusiast's speaker. If you want something you can take to the beach, buy a Bose Wave Machine. For people willing to invest some thought and care in planning and operation, maybe this is it. Lowthers are not for everybody but they are for some of us. You know who you are!

THE CLUB SCENE

Lowther-Voigt developed an interesting sort of distribution system specially tuned to the needs of the hobbyist. On the one hand, Lowther offers a line of finished cabinets for the global retail market, with the 15K$ Opus One at the top of the heap. On the other hand, Lowther services the hobbyist and experimenter market through a network of Lowther "clubs"— enthusiast-run organizations providing drivers, cabinet plans, service, technical assistance, and other forms of emotional and practical support.

The club scene is a parallel channel of availability distinct from the "official distributor" network. The clubs are run by and for Lowther fans who are in it for the love of the product. I consider myself a fan of Lowther drivers but I gotta say that these club guys are heavy-duty, big league Lowther-Voigt nuts. A few weeks ago, I wrote Andreas Mau of Lowther Club Deutschland just to introduce myself and say hello. Andreas was so excited about the opportunity to spread the gospel that he sent me 26 faxes so far and several hundred pages of related info, including a cabinet design article he wrote back in the mid-eighties called "Lowther for Life!!!" and pictures of what appears to be a religious shrine with a Voigt theme. His faxes come signed "Lowther is the answer!!!, Andreas" — hard core, indeed!

The German and Danish Clubs work together closely to promote and support the proliferation of the speaker with the white cone. Hundreds of people belong to the European Lowther Clubs and it seems like they have a real nice thing going on, sharing information, circulating new cabinet plans, and generally having a good time.

LOWTHER CLUB OF AMERICA

Unfortunately for us Yanks, Lowther hasn't had a US distributor for many years. During the '50s, Lowther cabinets were produced here by Brociner under license. In the early '60s, Stuart Hegeman designed a loudspeaker for Harmon Kardon called the "Citation X" featuring the outrageous-looking special version Lowther (pictured on the cover of this issue) mounted in an up-firing position. Hegeman also designed at least one top of the line cabinet for Lowther for the British domestic market, the stately Lowther-Hegeman Corner Reproducer.

Although there was a powerful Lowther cabal among top ranking Stateside hi-fi operatives during the '50s and '60s, it was an extremist fringe scene. After the new generation came in and tubes went out, Lowther vanished from the US market. The way I see it, Lowther, old chaps, you didn't miss any action not being in this market while we were all lusting after Vandersteens and Apogees to go with our Adcom 555s and Krells.

But nowadays with all this triode stuff going on, Lowthers make sense again. With the A series you can get 100 dB sensitivity in a reasonably proportioned box and NFB SE friendly 16 ohm voice coils as a bonus. There ain't nothing like a Lowther but a Lowther, so check out a Lowther if that's what you're after.



Andreas Mau of Lowther Club Deutschland with his prized Opus One corner horns.

That the time is once again ripe for Lowthers was not lost on Mr. Tony Glynn. Tony is a longtime Lowther enthusiast and Oregon Triode Society member who somehow got suckered into selling his prized Acoustas during a move in the early '80s, one of those deals that makes sense at the time but leads to eternal regret and dismay, kind of like that time I "lent" Vinny Gallo one of my Altec 755As for a "few days" three years ago.

The story goes something like this: Tony contacted the factory with the idea of purchasing a pair of drivers to get back with the one way scene and, a year later, he's forming the Lowther Club of America! Alright! I'm joining. I want to be the second US member, after Tony Glynn of course.

The major point of debate among Lowther freaks is over which cabinets to go with. Like all worthwhile audio questions, there is probably no correct answer to this one. For example, some people who have owned various old cabinets prefer certain new cabinets, while others stick with the old 50s and 60s designs, decrying the new stuff as a sign of the decline of Western Civilization.

There are lots of plans out there for Lowther cabinets. The 1964 Acousta design so heartily recommended by Haden above is a reasonably easy to build, high-performance box. Other cabinets range in complexity from later Acoustas with a flat front for simpler carpentry, to mind-boggling projects like the old TP-1 and the modern Opus One corner horn (60 precision-cut parts per side!). Since I never saw or even heard of most Lowther cabinet designs, don't ask me! Find yourself an "expert". Join the club. If you come up with something really good, be sure to let us all know. I like to think that the "best" Lowther cabinet has yet to be built. Gentlemen, start your table saws!

The way I see it, a good old answer to an even older question is always worth a listen. Since Lowther traces its heritage to one of the very first moving coil speakers ever, it's a very old answer indeed. The fact that Voigt's genius loudspeaker is still alive and well more than fifty years after its conception suggests that a lot of people over the ages thought it was a very *good* answer too.

You can't accuse me of nostalgia for old British technology, even though I do think some of it is pretty cool. I'm from Philly and I grew up playing stickball not cricket. I'm just looking for a good speaker to use with my tube amps like everybody else. My plan for a better audio future in my living room doesn't rule out giving the classic solutions another shot in a new context. Scholars say that each generation writes its own history, weighing past deeds in light of where they are and what they aspire to accomplish. In my picture of 20th c. audio, Voigt is a giant and whizzer cones aren't always a joke.

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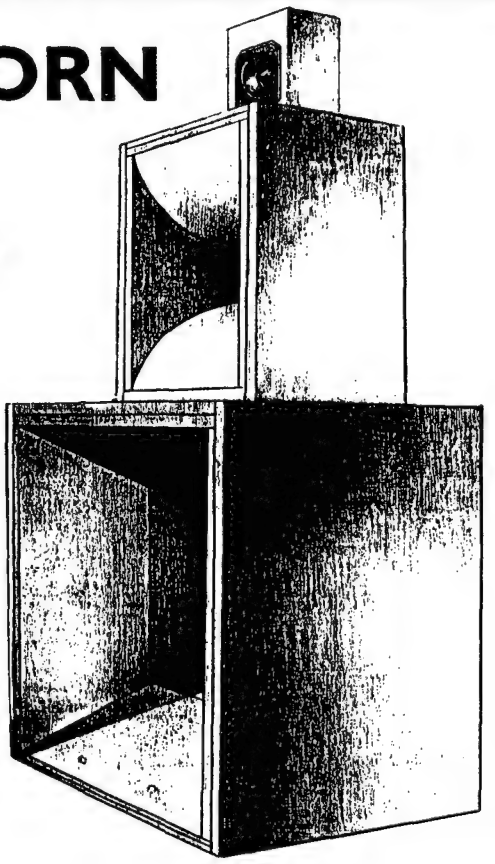
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FLESH AND BLOOD

THE REICHERT 300B

by Herb Reichert
Audio Note, NYC



The light from the streetlights mixes with the glow of the bright emitters in my listening room. Nyiregyhazi plays Liszt in front of me and my skin seems electric but I am completely relaxed. I let out my breath and my pulse is near flatline. Audio can really be good to us . . . if we let it. This is why we must seek to create and explore the frontiers of audio. This is why many of you build your own audio equipment.

I started building and designing my own audio because I am a 'gearhead' by nature, not because I thought I could do better than the pros. However, one day I took the negative feedback out of an amplifier I had built and my whole body went limp. Big symphonies by Mahler began to expand and breathe. A strong sense of voluptuousness replaced a feeling of tension and hardness. Average and poorly recorded program began to become part of my midnight repertoire. I concluded I was on to something important. I realized that there must be more design decisions, big ones, like this one with the feedback, that impact the basic character of my system. This is the point at which I became "high fever". I now had a sense of what was possible. I began to engineer with a purpose.

Over the last decade, I looked carefully at each part of the audio amplifier design process. My first rule was: take nothing for granted and keep an open mind. This attitude steered me down many wrong roads; like the six months I spent chasing A/C balance in push-pull amps or looking at pentode driver stages. Big dead ends!

On the other hand, looking into every detail of the single-ended, directly-heated triode amplifier has netted results beyond my wildest dreams. The whole world of high-end audio is changing and believe me, it is the result of the work you and I and our friends are doing in our homes. We are experiencing a 'new dawn' in audio, but this new dawn is only the beginning and there is much NEW work to do. So, I want you to take this design as a beginning and build on it. Apply your own audio ethics and benchmarks.

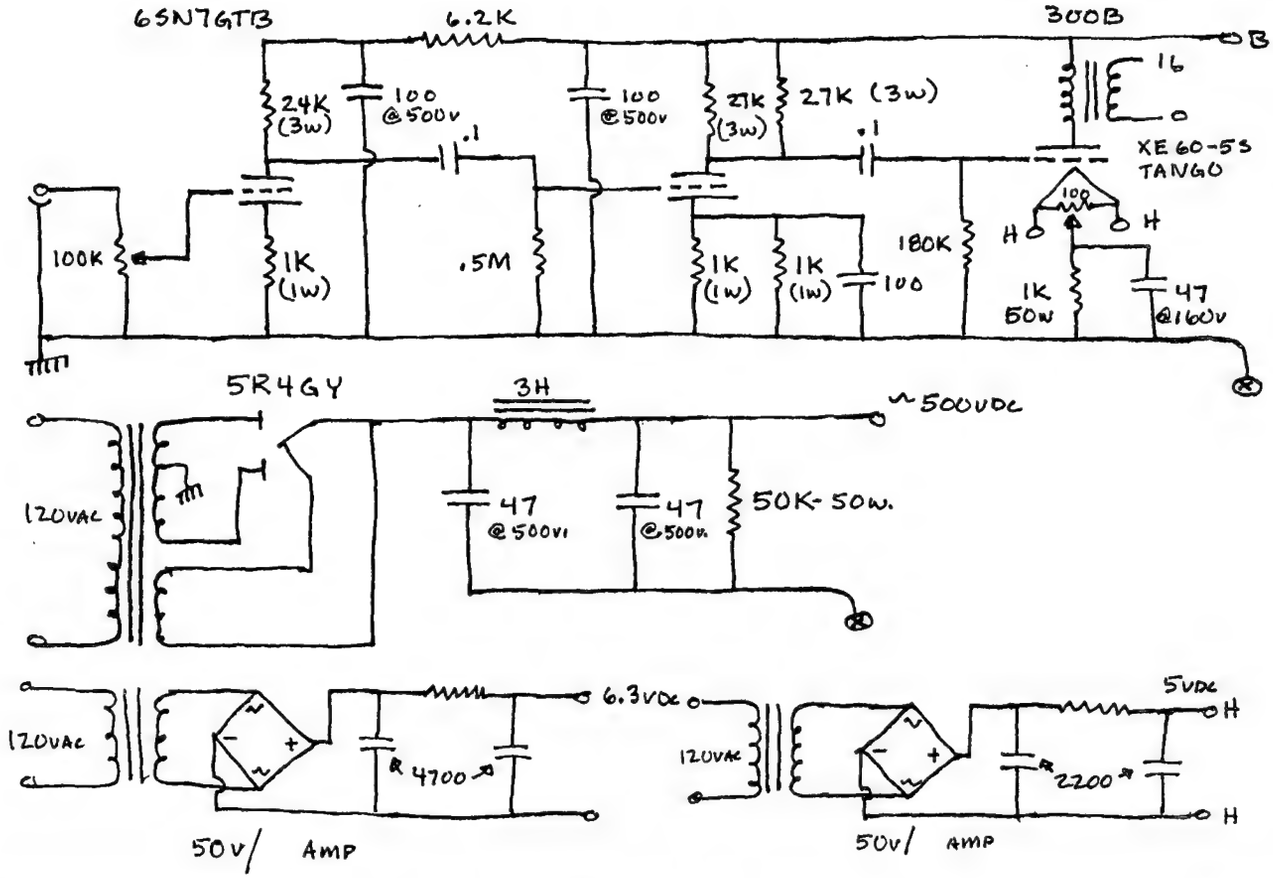
From the letters and phone calls I receive, I know that many of you believe that if you can get a schematic for a great amp, then go out and buy what you think are some great parts, and put it all together carefully, then you will end up with a great amp. Sorry, it just doesn't work that way. You might get a GOOD amp by this method, if you are lucky and inspired, but to get a GREAT amp you must suffer. Whenever I build a BAD amp, and I have built quite a few, J.C. always says, "Welcome to the next level." It is the failures and the mistakes that get you to the other side of the mountain. Each failure makes more clear what you do not want. Each success enlarges your vision of what is possible. The process of building is to wire your mind, to focus your sights on that point on the horizon where greatness lays.

I know the Reichert 300B-SE amp doesn't look like an unusual or original design. But, on the test bench, this amplifier design sets very high standards for bandwidth, rise time, and distortion. My main design goals were vividness, body, color, and dramatic contrast. I want a vibrant, breathy, gripping sort of presentation. I am an artist, a painter in the painterly, romantic tradition. I want my hi-fi to paint with strong, rich strokes.

What I don't want is distant, thin, or mechanical sound. Lots of flesh and blood. Lots of drama and empathy and lots of Technicolor and Panavision; this is what I was after when I designed this amp. Each design decision was a trial and error attempt to get to this end. Please understand, this is not a 'part of the month' design. Each parts choice has a personal evolution, all yin/yanged to my taste. If you change ANY part, it is your amplifier design, not mine.

Amplifiers are engineered from the output terminals backward. The amp/speaker interface is EVERYTHING and one's focus must always be on the 'black & red'. Amplifiers are always designed for a particular speaker or speakers and any amp designer who says differently is trying to sell you something he doesn't own. How the amplifier behaves into the chosen speaker load is the first point to consider when making all major engineering decisions. This amplifier was created to power Altec VOTs, Edgarhorns, WE-755As, and Altec 601As. I have also discovered that it works very well with LS3/5As, AR-M1s, Lowther PM-6s, and Audio Note Model 2s & 3s. I used a circa 1946 Altec VOT system to do the initial design work. Final touches were done with the Onken/Edgar system and Audio Note Model 2 & 3 speakers.

Output transformers are the cornerstones of any tube amplifier design. Since 1980, I have tried outputs from UTC, ACRO, Peerless, Dynaco, Fisher, Partridge, Western Electric, Chicago, Hammond, Magnequest,



RCA, Audio Note, and God only knows...? I prefer the Tango to any other. I distributed Tango in the U.S. until 1993. Maybe that's why I began this design with the Tango XE-60-5S single-ended output. I do not care how "romantic" you want to be, you must have speed and bandwidth. An amplifier that is slew limited or unstable outside of its passband will never have good tone character.

I believe the ultrasonic and infrasonic behavior of a SE amp must be carefully examined. Excessive phase shift or ringing in these regions will surely sabotage the amplifier's potential for greatness. If the output transformer rotates phase more than 40 degrees below 100 Hz, the amp will sound slow and the bass will seem to lag behind, lacking "tunefulness". Bass transients will sound dull. Likewise, if there is ringing in the ultrasonic region, the amp will sound hard and 'hollow'.

The proper selection of core material, core size, aspect ratio, and winding technique is far more critical in SE designs. Poor choices lead to soft, lazy, unrefined sounding amplifiers. The Tango line is unique in that it is the product of two decades of continual development. World-wide, there are thousands of SE amps with Tango outputs. The Tango XE-60-5S measured 18-80 kHz, -2dB in this amp. This is at 7 watts! Remember, I do not sell these transformers anymore. I just still love them.

I chose the WE 300B tube after living with amps built around the 6B4G, 2A3, 50, 45, 801A, and the 10Y. 10Ys push/pull are still my personal favorite, but even the VOTs like more than 3 watts. Of the available triodes, the 300B plays the most records with the greatest ease and the most refinement. It is voluptuous and elegant. Also, it is the ONLY tube I am aware of with perfect sample to sample consistency. The Western Electric 300B is always quiet and it will last forever. There is a hypnotic quality to the 300B sound that draws me into the performance like no other type of amplifier.

Operating points are next on the design agenda. My best friend and tube maven, J.C. Morrison, has already written the book on this subject: run your triodes hot! With pentodes, I like low plate voltages and high current. With triodes I like high plate voltages AND high current. I run the WE 300B at 425VDC on the plate and 80mA standing current. I want deep class A1. I want to tickle the center of the B/H curve and swing very little current across the power supply. Symmetrical clipping and fast graceful recovery are a combination of power tube operating point, driver stage design and power supply engineering. These three elements work in concert and must be designed together with a clear sonic goal in mind. The amplifier's ability to drive speaker loads with ease and refinement will be seriously handicapped if we make a bad decision here.

I chose the 6SN7 cascade after examining the distortion spectrum and sonic character of the SRPP, transformer coupling (Tango NC-16 and NC-14), 5687 anode follower, the mu-follower, and several variations on direct coupling. With the R-C coupled 6SN7 and 500VDC raw supply the amp 'locks' into class A1 with a minimum of A2 voltage. The 12K plate load on the driver stage gives me the rise time and low odd-order distortion product I wanted. Don't laugh, but I only like the GE 6SN7GTB in this position. You must use GTBs to get the required plate dissipation and the GE version sounds best to me. The first stage is R-C coupled to the driver stage to hold the output tube grid swing to max even with poorly matched tube sections or aging tubes. Direct-coupled designs seem to change their sound over time even though their minimum phase character is highly appealing. In this design, the time constants have been very carefully considered, so don't go changing any resistor or capacitor values.

The power supply is everything in these little amps and it also seems to be the area where designers agree the least. All the SE 300B amps I have heard sound very different from each other. Some sound more mechanical than the worst solid state designs. The reason, I expect, is wildly different ideas on power supply design. First rule of triode amp design: Solid state rectifiers = mechanical sound. You don't think so? Then you haven't really compared. I promise you, IF there is only ONE thing I have learned in ten years of amp design, it is this first rule. A lot of time went into selecting the rectifier tube for this design. Normally, I use the WE 274A/B, but this amp sounded best with the RCA-5R4GY.

The pi-filter is the heart of this amplifier. If this amp sounds better than others, it is probably due to the choke/cap selection on the pi-filter. I don't like to waste a lot of energy charging and discharging caps. I want a narrow torque curve - high rev supply. Low impedance and minimum storage gives fast recovery and fine texture to the sound. Remember, most amps under 2000 watts are running at or near overload. Let's make them sound unstressed at overload. Then the music will sound unmechanical. The power transformer should be rated at least 500mA at 800VCT. An even higher current rating is better (I use 750mA) because I want a small value bleeder resistor at the end of the filter. I like to bleed at least 25% of the total standing current. This stabilizes and regulates the supply. With the small Black Gate caps, the heavy bleed appears to enhance the clipping characteristic.

We want 480 to 500 volts across the output of the pi filter. The choke should have a DCR of less than 300 ohms. I aim for 10-20 Ohms DCR! This is a big chunk of iron, but it is a very important part of the design. The number of Henrys is less important than the DCR rating. Two to ten Henrys is fine. We are looking for a B+ that is fast and linear, but loosely and naturally regulated. Remember, the reservoir and decoupling capacitors are part of their respective stage's transfer function. This means that they are just as important as the tubes in determining the linearity and character of the amplifier.

For caps there are a few choices. I have tried all the usual stuff: WE oil and paper, photoflash, polypropylene, etc. The Black Gates (47uf at 500vdc x 2) are now my first choice, but only if you play music every day. These are electron-transfer/electrostatic and must be kept charged. They take a full 24 hours to recharge when left to discharge. These are not electrolytics. They work more like an electrostatic speaker. There is no electrolyte or electrochemical delay. These caps are super wideband, linear, non-resonant, and quiet. The Cerefine are almost as good. They use a ceramic powder instead of pure carbon like the Black Gates. This ceramic powder allows for a quicker charge up time. Both caps behave very gracefully under A/C conditions. Do not use polypropylene. If you do, this is your amp design, not mine.

I am not going to get into the parts philosophy thing except to tell you I have tried everything I could lay my hands on. My ideas change daily so here are today's recommendations. No Teflon. No silver plated wire. No MIT multi-caps. No metal film or metal oxide resistors. No polypropylene caps. No Vitamin Qs. No Solen. No REL caps. No Holcos. No metal oxides. No Vishays. No SCR. No MKP-1845s. No solid state diodes. No solid state current sources. No silicon anything. If you use this stuff, you know who's amp design it is NOT.

Please use Allen-Bradley resistors in the plate circuits. Paralleled resistors, in plate circuits, are quieter and sweeter sounding. Use Audio Note Tantalum resistors in the cathode and grid circuits. On the cathodes of the 300Bs use Caddock 50 watt MP 850s. You can use Caddock MG or MX in the plate circuits if you are a noise freak, but I think the A/Bs sound more relaxed and showcase the wood and brass tones on orchestral music. I have only three recommendations for coupling capacitors and they are all Audio Note. Due to my affiliation with Audio Note you probably won't take my coupling cap recommendation too seriously, but that's OK. You lose! If you want even a chance of catching my Ongaku sonically you must use Audio Note silver foil paper in oil coupling capacitors. If you can't afford these use AN copper foil paper and oil capacitors. There simply are no other choices.

Wire is a separate issue. Wire is a system thing. After twelve years of building amps, I only KNOW two things for sure: 1) Use tube rectifiers 2) You can never have too much silver in the signal path. Go without food or clothes, but buy lots of records and wire your hi-fi in silver. Audio Note or Kimber silver wire are my first choices for internal wiring of this amp. If you can't afford this stuff, just use Carol PVC hook up wire. Nothing is worse than silver-plated copper. Stay away from all Teflon coated wire if you are looking for relaxed natural sound. Believe me the Carol PVC stuff is good for everything in your system from the tonearm to the speaker. If you can't afford silver, and you trust me, try it.

In fact, if you want to build this amp on a budget, try this—you can still say it is my design. Use the Tango XE-20S or the Audio Note outputs. Use the Carol PVC wire, the AN Paper and Oil Caps (Regular type), Allen-Bradley resistors, and Sprague or Mallory power supply and bypass caps. You will lose some of the refinement but none of the naturalness.

If you make substitutions with parts try to avoid plastic, especially hard plastic. Think voluptuous and colorful. Oh yeah, even if you are on a budget, try to use a copper chassis, 2-4% silver solder, and high quality ceramic tube sockets.

Please, try to wire the circuit just as given on the drawing, observing the ground points of the cathodes and the PS capacitors. Do not buss the power supply caps. The pi-filter and the 300B cathode resistor should be grounded at the same point. Likewise the 6SN7 cathode resistors, the driver stage bypass condenser and the decoupling capacitors should all go to the same point.

All of this design talk may be for naught. You see, I believe most deeply that the real magic ingredient in any amp design is the *wu* of the designer. This *wu* flows from the designer's hands during construction and raises the effort above the common and imperfect. Therefore it might be best if you design your own amplifier, for your own speaker, based on what you already know and what you think of my ideas. My philosophy rests on the romantic and the expressive. Drama and contrast with the grace and poise of a bullfighter are my audio system goals.

This circuit and these parts choices were developed inside the world of MY hi-fi—to my taste! If you want an exceptional music reproduction system in your home you must first develop your internal reference for natural sound. Then you must outline your aesthetic and make a series of design decisions that reflect that aesthetic. But remember, you won't be happy if you acquire your aesthetic from reviews and audio pundits. You must discover your own. Trial and error is tedious and it takes a long time to become a wizard, but I am sure you will look good in the wizard's cap.





Amigos:

After finishing work on Edgar's Midrange Horns and Monolith (which took several months of hard labor and lots of patience—all well worth it), I decided that the next project would be a lot smaller. This decision made my wife extremely happy.

I got myself a steel chassis (17" X 3") and went to work on a PP 6A3 amplifier. Why PP? Because I already had a pair of Peerless 5K outputs. I also got lots of help with the electronics from James Novak, the biggest and brightest electronic nut on the Atlantic coast.

I wanted it to have that old 30's or 40's retro look. Consequently, I got a pair of panel meters, an eye tube, and a few cans of black wrinkle paint. I spent a few weeks laying out the chassis, till the look I was after started to emerge. Then it was just a matter of putting to work all those years experience as a machinist.

I also wanted to use tubes that have a certain amount of presence, or should I say "color". For this I chose mercury vapor rectifiers and an eye tube. There is also an OD3 which, aside from regulating, has that soft pinkish-red look that reminds me of those beautiful sunsets on the west coast of Spain where I grew up under El Generalisimo Francisco Franco's watchful eye.

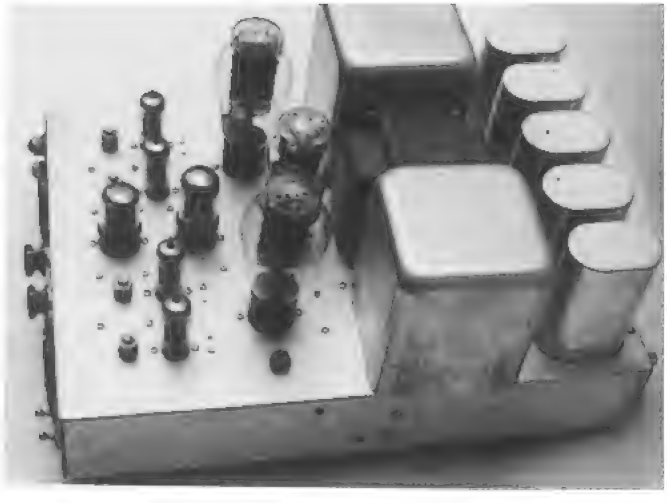
Speaking of eyes, this tube serves a practical purpose as well. It reminds me that the amp is on, in case I do not notice that the 6A3 filaments are red hot or that the mercury in the rectifiers is vaporized or that the panel meters are pointing to 120 mA.

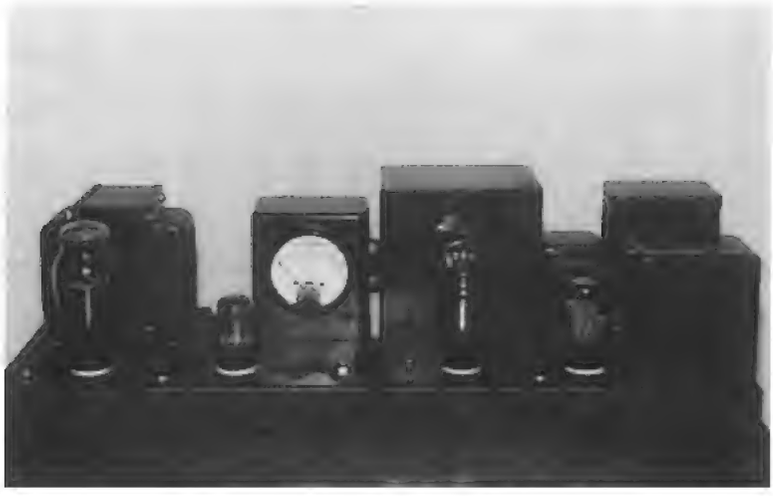
The power supply uses four polypropylene in oil caps (30 mF@700VDC) and there is not a single electrolytic anywhere else, except for a 10000 mF filter as part of the output tube filter. This amp puts out 8 Watts of pure class A and sounds better than any PP triode I've ever heard. When I first started this project, I never thought it would be so involved, complex, and at times frustrating, but in the end it was incredibly rewarding.

Raul Gil
New Jersey

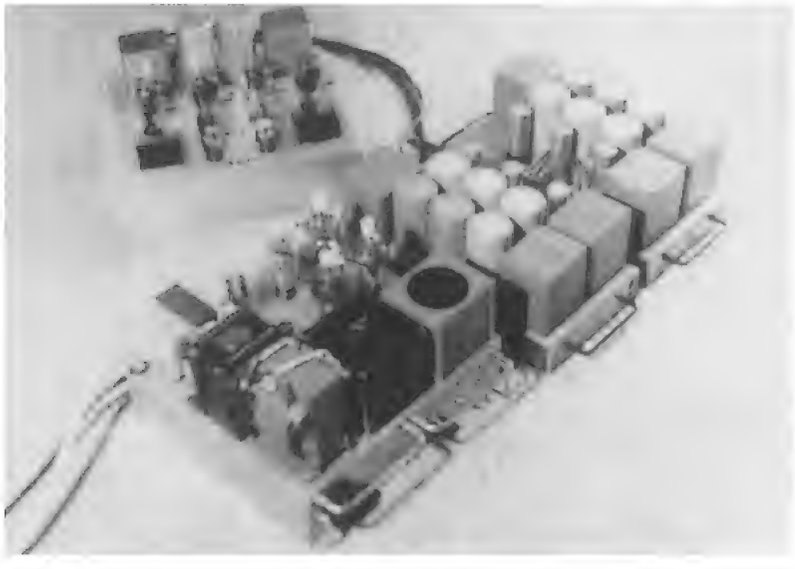


Raul Gil's latest project. . . Direct coupled SE 300B with 5692 + 6SL7 drivers regulated by four 6S4s. The 300Bs are regulated by a 6AS7.





Ed Johnson of Crandall, Georgia turned out this classy two box 6B4-G SE with MQ FS-030 iron.

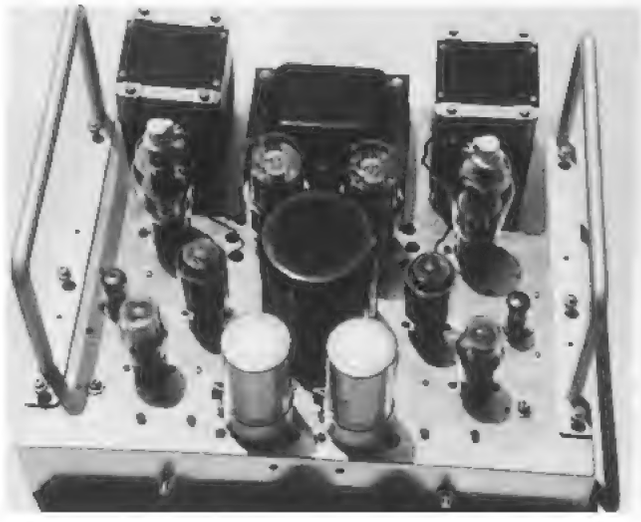




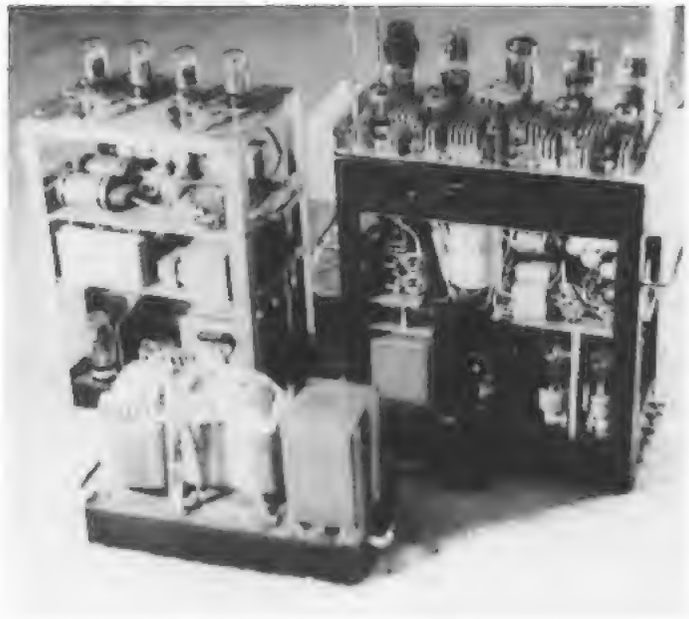
Dr. Lo Mu Triode waiting for feeding time in the Triode Wing of the Kansas City Institute for Terminal Audiomania, his home away from home.

The Doctor's other 1994 homespun amps: PP Class A 6B4-Gs with a dual diff-amp 5687 front end current sourced by an additional 5687. The input is direct coupled to 6BX7s running at a high current 29 mA per plate for a driver stage with real "moxie".

Experimental SE807 built by Eric Carmichael of Tucson, AZ. The amp uses a pair of 6KW 50 Watt Partridge 5353 transformers designed for push-pull operation. Plays real good as a midrange amp in a bi-amp setup and does decent square waves above 500 Hz, but the bass is "worse than absent" according to the builder. Fun experiment though.



Push pull monster from the lab of Jeff Medwin, AKA "Dr. Lo Mu Triode" of KC, MO. This stereo 250 PP amp uses 76/6P5GT input tubes, type 45 drivers, and UTC phase splitter/driver transformers, feeding the grids of a pair of Globe 250s wired into a pair of vintage Peerless outputs. The outboard power supply chassis (plural) provide a separate regulated, highly filtered supply for *each* stage. The power supply uses mercury vapor rectifiers and select low DCR transformers and chokes. Dr. Lo Mu insists that his extremist approach to amp design yields a level of sonic results *entirely unobtainable* through lesser means.



The Rejuvenation Process

How to get the longest life out of your power triodes

by Heiner Jakobi, England

Since there is a shortage of high quality power triodes just like in the 1940s— although, touch wood, for different reasons — it is necessary for the tube amp user to consider some old recipes which were common in the 1940s and earlier on. This one was passed on to me by an old tube lover from Germany.

I will use as an example the European type AD-1. This tube is considered by some to be one of the best output triodes ever built and it has become very rare.

The AD-1 was invented by Philips in Holland and built there under Philips and Valvo and by Tungsram and Telefunken in Germany. Later, Tesla made a copy which was not on par with the Western European production. A professional version with different basing called the Ed was produced by Valvo under contract for Siemens for use in telecommunication systems. Also, RFT from East Germany built a tubular version, later replaced by the even more powerful, indirectly heated Ec.

A regenerated tube does not look like a new tube. The shiny getter deposit will still look "burnt" or "bleached" like it was — but the tube will perform for its full life one more time, usually another 2000 hours. If regenerated yet another time, it might last another 50%!

AD-1 data
Filament 4V/0.95A
Plate voltage 250V/60 mA
Negative grid voltage - 45V
That's all you need to know!

We start with the heating process: Instead of 4 volts we use about 7 volts and overheat our triode for about 10 minutes! Then go down to 5 volts on the filament and add plate voltage. Apply so much that the plate starts to glow red. That's right!

Most important is a milliampere meter to read how much current the triode is drawing. With an AD-1, the max current is around 250 mA and this occurs around 600 V on the plate.

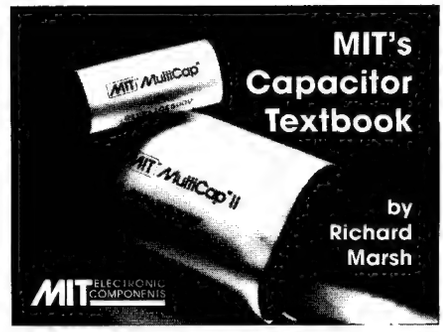
When new tubes are produced, a small amount of barium compound is vaporized inside the sealed tube in order to bind gases and impurities inside the glass. What we are doing is using getter material that wasn't used during the initial production process. Up to 60% of the barium is left over from the first process and we can use this potential now to rejuvenate the tube! As you heat the tube, you will see the barium glowing green, evaporating, and doing its proper job all over again.

The critical thing in this process is that you keep your eyes on the meter. After about ten minutes (and this time will vary), the current drops. You must switch off IMMEDIATELY!!! One second too late and the tube is dead! Forever. You have not lost anything since you couldn't use it anyway. I leave all you tube lovers to experiment with this idea and to use your common sense about which settings are correct for each triode.

Some Guidelines:

1) Heat the filament for about 10 minutes with around 40-50% more than the rated value.
2) Drop down to around 20% overrated filament voltage, then,
3) Add plate voltage until your milliamp meter does not rise, i.e. max current, and the plate shall glow red!!!
4) Keep your eyes on the meter until current falls and *immediately* switch off!

In the old days there were special tube rejuvenators on the market, but nowadays you will have to build it yourself!



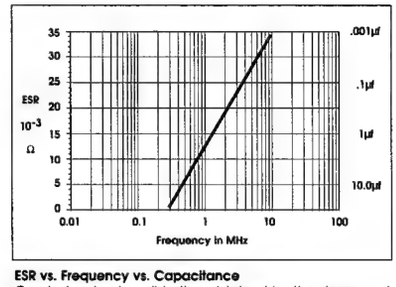
Debunking the Myths

Cap Myth # 2
The plate metal is the most important factor in capacitor performance.

Cap Fact
- The compatibility of the plate material with the ends' sprayed-on metal and the solder & lead metal brings about lower ESR (therefore better, more stable performance) than using exotic plate materials.
- Silver & copper foils are potentially good, but they must be made into a capacitor immediately upon manufacture. Otherwise these foils will oxidize quickly.
- Oxides form rapidly on silver and are difficult to remove. Oxides are difficult to attach onto leads, and create unreliable connections. Oxides also become imbedded in the solder, again creating an unreliable join.
- Use of high purity copper will reduce oxide formation in copper foils. But the molten metal sprayed on the cap ends, to connect the foil plate edges, is typically an aluminum alloy, which is incompatible with copper. This combination will corrode in time, through electrolysis between dissimilar metals.

Solution?
The MIT **MultiCap** uses the most compatible metals and alloys throughout. Our tin MultiCaps, for example, offer thick tin plates attached to tin-plated copper leads, hand soldered with high-tin content solder. This ensures reliability and long term performance, and lowest ESR for consistently fine performance.

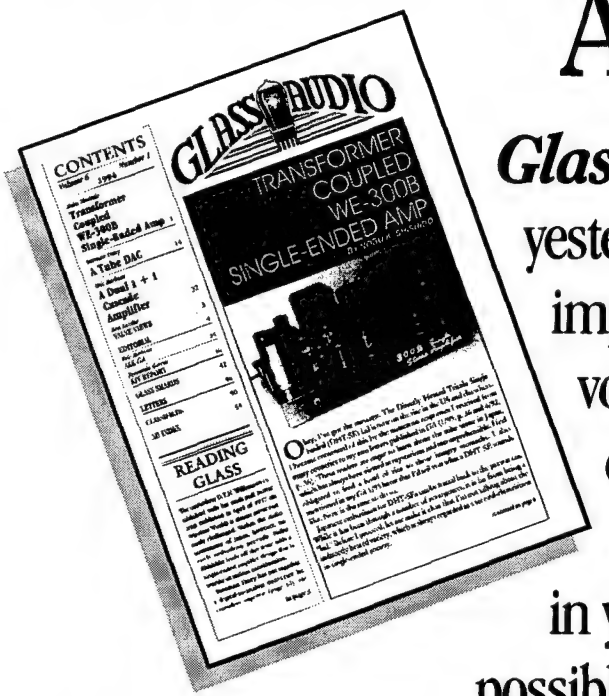
Watch for Cap Myth #3!



ESR vs. Frequency vs. Capacitance
Graph showing low distortion obtained by the decreased parasitics (ESR) of the self-bypassed MultiCap. MultiCap performance falls to the right of the line, indicating fewer parasitics, ie., fewer colorations & increased accuracy. Measurements of standard caps, even with exotic foils, falls to the left of the line, indicating compromised performance. (Measured at MIT)

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New Svetlana™ Triode Development SV811 Series

by George Badger
President, Svetlana Electron Devices, Inc.

Svetlana is Russia's leading designer and manufacturer of power tubes. The company offers a line of well-engineered, rugged tubes for broadcast and industrial users. Svetlana has been a leading vacuum tube supplier since it first developed electron devices in 1928. The company was founded in St. Petersburg in 1889 and began manufacturing incandescent light bulbs in 1913. Svetlana, which means 'light' in Russian, established a laboratory for developing vacuum tubes in 1928 and won the Grand Prix for transmitting tubes from the International Exhibition of Art and Technology in Paris in 1933.

Svetlana was reorganized as a privatized open stock company in 1992. In the same year, Svetlana Electron Devices, Inc. was formed to bring Russian power tube technology to the world outside of Russia. This U.S. based company owns a major share of the joint stock company and is working with the newly-privatized Svetlana in St. Petersburg to introduce tube types widely used in Russia and new to Western equipment designers. The companies are also providing exact replacement, plug-compatible Western tube types to broadcast and industrial end users and hobbyists.

Svetlana Electron Devices, Inc. has its corporate headquarters in Huntsville, Alabama with marketing and engineering offices in Portola Valley, California. Svetlana Electron Devices, Inc. manages the worldwide marketing, sales and support for Svetlana products. The company is led by a management team including old hands from the US tube industry and members of the Russian engineering and design group responsible for tube development, manufacturing and applications.

Svetlana has an exceptionally clean manufacturing environment, and its tubes are vacuum processed at higher temperatures than are common in the West. This enables the company to manufacture both thoriated tungsten and oxide cathode tubes with extended life and consistent performance. It also means that Svetlana's long life tubes can be backed by the most generous warranty in the industry.

The joint venture for power tubes has grown rapidly and has been so successful that we recently brought the Svetlana Glass Tube Facility into the organization. The work in the glass tube engineering and manufacturing complex is directed toward the world audio and instrument amplifier market. All marketing is through the joint venture.

SV811 Triode Development

The Svetlana Electron Devices, Inc. product line also includes some exceptional tubes made in other manufacturing facilities in Russia. An example is the subject of this paper, the newly developed SV811 series. It was developed in cooperation with the Electronpribor Manufacturing Corporation in Ryazan. The strict manufacturing and quality control systems at Electronpribor are on a level with those at the Svetlana complex in St. Petersburg where Svetlana ceramic power tubes and the majority of Svetlana glass power tubes are produced.

The newly developed Svetlana SV811 series audio power amplifier triodes are intended for use in class A, AB, or B amplifiers. The high plate power dissipation of 65 watts and the high plate voltage rating of 800 volts provides the capability of reasonably high power output in Class A circuitry.

The SV811 series design is derived from transmitting tube technology and manufactured under transmitting tube processes and controls. Unlike the typical audio power output tube, the SV811 is not an "upgraded" receiving tube. It is the smallest tube made in a *transmitting* tube plant rather than the biggest tube made in a receiving tube facility.

The SV811 series uses a directly-heated thoriated tungsten filament for the warm sound and soft glow of this classic cathode, familiar to audio people who know the visual beauty and power of the 211 and 845 triodes.

The emission performance of thoriated tungsten filaments under peak overload conditions is far superior to the performance of the oxide coated cathodes used in most familiar audio power tubes. Thoriated tungsten filaments offer consistently better sound over a longer useful lifespan than oxide cathodes. Thoriated tungsten filaments are exceptionally stable and not manufacturing process sensitive.

The SV811 series has two temperature-initiated getters mounted directly on the plate for superior gas absorption. This type of getter, used in high-power transmitting tubes, continues to absorb gases throughout the life of the tube. Consequently, they are more effective than the familiar one-shot "flash" getters vaporized during factory processing. Also, flash getters spew material over the inside of the glass envelope, impairing radiation cooling and spoiling the natural visual aesthetics of glass audio tubes.



SV811-10

The envelope of the SV811 series is made of a type of hard glass intended for transmitting tubes, which is highly resistant to power overload, overheating, and subsequent outgassing.

The internal tube parts are supported by ceramic insulators for high temperature operation and high voltage hold-off. Stressed mica supports are used against the envelope to absorb vibration, thus controlling microphonic effects. The internal structure is aligned with respect to the base pins to avoid internal shorts if the tube is operated in a horizontal position.

We recognize that audio tubes are usually installed on the outside of high-end audio amplifiers in plain view of people who truly appreciate a good looking tube. The SV811 will be controlled for external mechanical and visual characteristics in addition to electrical characteristics. These tubes feature a bright glazed white ceramic base which contributes significantly to the classic appearance. A matching glazed ceramic 4 pin socket, the SK4, will be available.

SVETLANA SV811-3 & SV811-10

We developed two new audio triodes for this series, the SV811-3 and the SV811-10, with amplification factors of 3.5 and 10 respectively, as indicated by the type number suffix. The following preliminary data is furnished to provide an introduction to the SV811 series and is subject to change. Interested parties are welcome to contact Svetlana for final data sheets which will be available by the time you're reading this article.

SV811-3

Amplification Factor (average)	3.5
Transconductance	1800µS
Maximum ratings	
DC Plate Voltage	800 V
Plate current, max signal	160 mA
Plate dissipation	65 W
Filament Ratings	6.3 V, 4A

SV811-10

Amplification factor	10
Transconductance	3900 µS
Maximum ratings	
DC plate voltage	800 V
Plate current, max signal	160 mA
Plate dissipation	65 W
Filament Ratings	6.3 V, 4A

The experience of Russian-American teamwork we enjoyed in the development of these tube types was greatly satisfying. It is indeed a pleasure to contribute to the renaissance of our favorite classic tube technology. At the same time we are bringing the rapidly growing Western tube market to the people who still know how to make tubes well. These exceptionally well educated and skillful tubemakers are masters at their art and therefore deserve to participate in our exciting Western World economy.

Special thanks to Dave Wolze for his time and assistance in providing real world measured audio amplifier service performance data.

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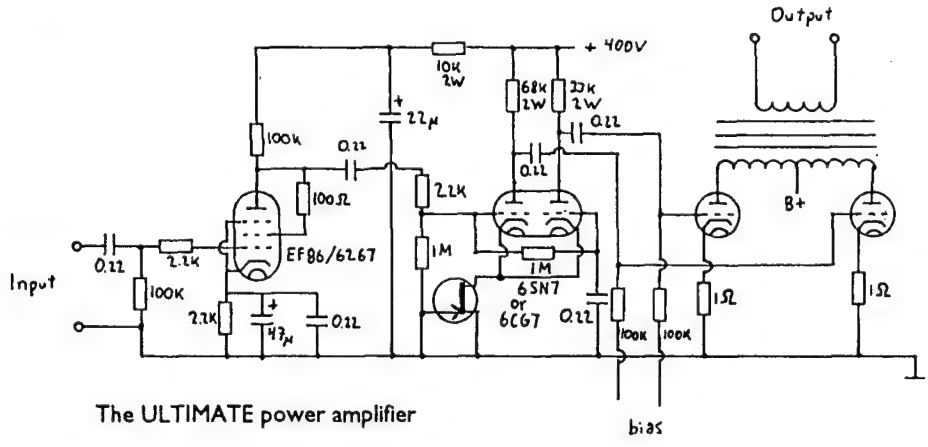
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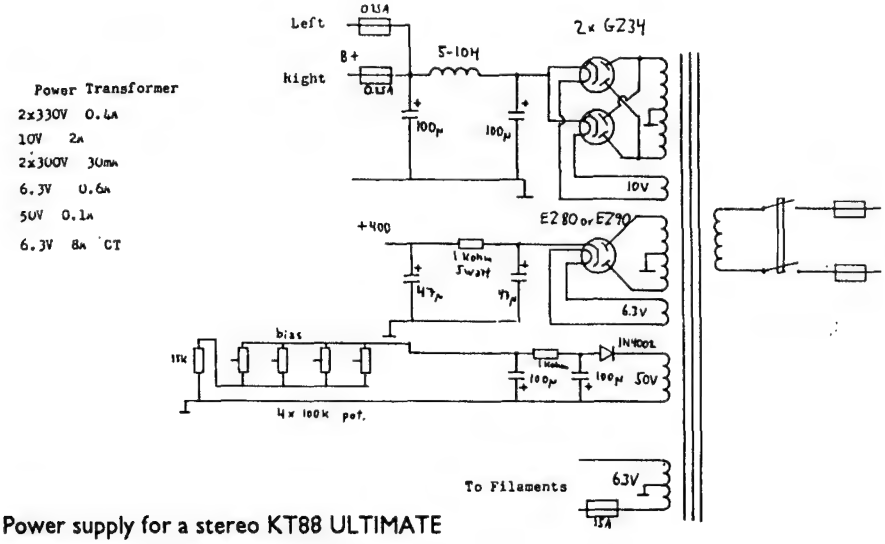
THE ULTIMATE

by Rickard Berglund, Höör, Sweden

At last, the battle between SE and PP is won!



The ULTIMATE power amplifier



Power supply for a stereo KT88 ULTIMATE

Tube	B+	Pri Z	P_{out} W	Plate I mA/tube	Bias
2A3	250	6600	7	60	-45
300B	350	7600	14	80	-72
6C19P	250	13000	6	40	-100
6C33`	250	2800	18	150	-100
6080	180	5200	7	70	-75
6336	250	3500	15	110	-120
6L6 *	400	13000	9	50	-38
KT-88*	400	8000	15	80	-43
PL519*	400	9000	18	80	-55?

* triode connected

TABLE 1

Determining transformer secondary voltage for desired DC output:

Capacitor input filter with solid state full-wave bridge or full-wave vacuum tube rectifiers.

DC Volts	SS bridge	Tube
180	140	2X160
250	190	2X210
350	270	2X290
400	310	2X330

When solid state rectifiers are used, the transformer secondaries should be rated for twice actual current.

TABLE 2

Many people like single ended amplifiers because of the natural harmonic relationship of this type of amplifier. The second harmonic dominates over the third harmonic, the third dominates over the fourth, and so on. The main disadvantage of single ended amplifiers is that the output transformer must be expensive and heavy in order to maintain low bass response.

The ULTIMATE amplifier consists of a standard push-pull output transformer connected to two triode output tubes or two triode connected pentodes or tetrodes. The drive signal is not equal for the two tubes as it is in a push-pull amplifier. In the ULTIMATE amplifier, the drive signal for one of the tubes is twice as big as that of the other tube. This approach produces a harmonic spectrum very close to that of a single ended amplifier. Another advantage is very smooth clipping, much better than a push-pull amplifier.

The ULTIMATE amplifier circuit is shown to the left. The transistor can be any low noise J-FET with an Idss of 8-10 mA. The one ohm resistor in the cathode circuit should be used for bias measurements. If you use directly heated triodes, place the resistor in the plate circuit instead.

Table 1 shows you some of the output tubes that you can use. The damping factor is dependent on the output tubes: KT-88 provides a damping factor of 4, 300B gives 5, and 6336 gives 6. The input sensitivity is also dependent on the choice of output tubes. A volume control can be fitted to the input if desired.

Details of a power supply for a stereo KT-88 ULTIMATE amplifier are given. If you use 6336 or 6C33 output tubes, you must use one power supply per channel or substitute solid state rectifiers for the GZ-34 tube rectifier due to high current requirements. I have not done any distortion measurements but I estimate that the ULTIMATE amplifier gives 4% second harmonic and 1% third harmonic at full power output. Table 2 provides transformer secondary voltages required for different tube types.

WORDS OF LOUDSPEAKER WISDOM (the BIG ten)

by Ray Newman

0. If left alone, solutions to acoustic problems will eventually be resolved by a creeping Darwinian process. Better solutions will occur with increasing frequency under conditions of use, until they eventually become the norm. Applying keen intelligence gets you there faster and with more pizzazz.

1. Loudspeaker design is a technologically based art form.

2. Perceptions mean a lot--especially *visual* perceptions.

3. Get to know continuums from catastrophes. Most matters of acoustics respond gradually and forgivingly to small changes and won't crash. Just don't miss drilling the loudspeaker bolt-circle diameter by more than 1%!

4. Know how to relate dBs to subjective experience.

5. The louder system *always* sounds better in a direct comparison.

6. Understand the concept of using the volume of space allocated to a loudspeaker system in the most efficient manner possible, even if you must make compromises later.

7. Watch out for the implications of the small and large-signal relationships once you find out what they are.

8. Learn to separate first-order technological matters from second-order ones, much less third-order ones.

9. Send the acoustic message in the right direction as much as you can. Loudspeaker directional characteristics count.

10. Beware of the "Laws of Physics"--people who use this term often don't know what they are talking about.

This document was passed around in a loudspeaker engineering lab as a "philosophical" offering some years ago where it pretty much got lost in a black hole. Here's a copy for posterity.

AUDIO NOTE

MAKING THE BEAUTIFUL - TANGIBLE

You have just started listening to your first triode amp. Reproduction now seems a little vapid and under powered for your speakers which are left over from your previous, non-triode system. You were hoping Single-Ended would bring new excitement, but your recordings are not demonstrating the magic and vibrancy you thought you were going to get with the change to triodes. Believe me, this is where every experimenter with this new technology ends up at some point. I was there five years ago, before I got into big horn systems.

Sadly, after four years of hard work, I had to give up on the horns. They seemed to capture the dynamic signature of the musical presentation, they got the leading edge of transients, but they seemed to lose the harmonic development that follows the leading edge. The room acoustic, the overtone structure, the sense of a whole energized musical environment was lost on the horn system. The horns had difficulty being subtle or refined.

When I gave up the horns, I was back at the start looking for a speaker to use with low power triodes. At this point, I was just tired of the struggle. I wanted to find a speaker that would showcase the differences in amp design and let me focus on investigating new program.

Now, I am sitting back, smoking my pipe and selling Ongakus. I can afford ANY speaker that will show off the radical perfection of Kondo's design. You know what? I was a slow learner, but I found the speaker that does the most things right with SE triodes. The answer was right in my back yard all along. The Audio Note Model 2 & 3 speakers allow 7 watts to play full-range, deep, rich and fast. With these speakers, reproduction is tonally correct, unstressed and natural. I use the silver wired Model 2/SPX ($2,695) to demonstrate the Ongaku ($89,000). Don't spend the next five years trying to "get your system together." Pick a speaker you can live with for a long time and design your system around it.

HERBERT REICHERT
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AUDIO NOTE NYC
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Try a screen driven driver stage

by Rickard Berglund

Some output tubes (211, 845) need a very high drive voltage with low distortion. Some tube freaks have used the 300B tube as a driver but it is very expensive. Others have tried to use a triode connected EL34 but it is not linear enough.

A pentode driven on the screen grid is very linear. I have tried this concept in a new driver stage, as shown on the accompanying schematic. The first two tubes V1 and V2 form an asymmetrical mu-follower. V3 is a screen grid driven pentode. Adjust the potentiometer R9 to 350V DC at the plate of V3. You can use many different tubes for V3.

I made distortion measurements for some different tube types with the results given in table 2. EL36 and 5881 are the two best tubes. The linearity of these two tubes in this "enhanced" mode is even better than for a 300B tube used as a driver.

The sensitivity of this driver stage is so high that it can be used direct with a CD player. Use an 100k ohm pot as volume control. Both the 400V and 700V supplies should be well filtered, maximum ripple 2mV.

You can of course use higher voltage than 700V for better linearity. The EL36 tube can withstand more than 1000V. The 6DN6 tube can also be used for very high operating voltages. Never use more than 1000V B+ supply voltage and be sure to set the anode voltage to 50% of B+ voltage. Use a separate filament supply for V2. Be careful, high voltages are dangerous!

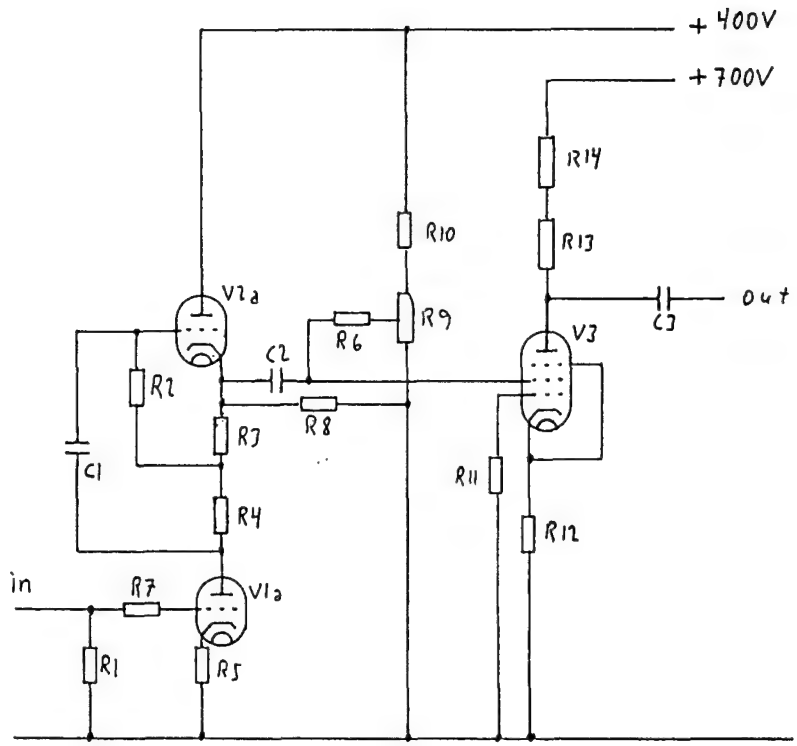
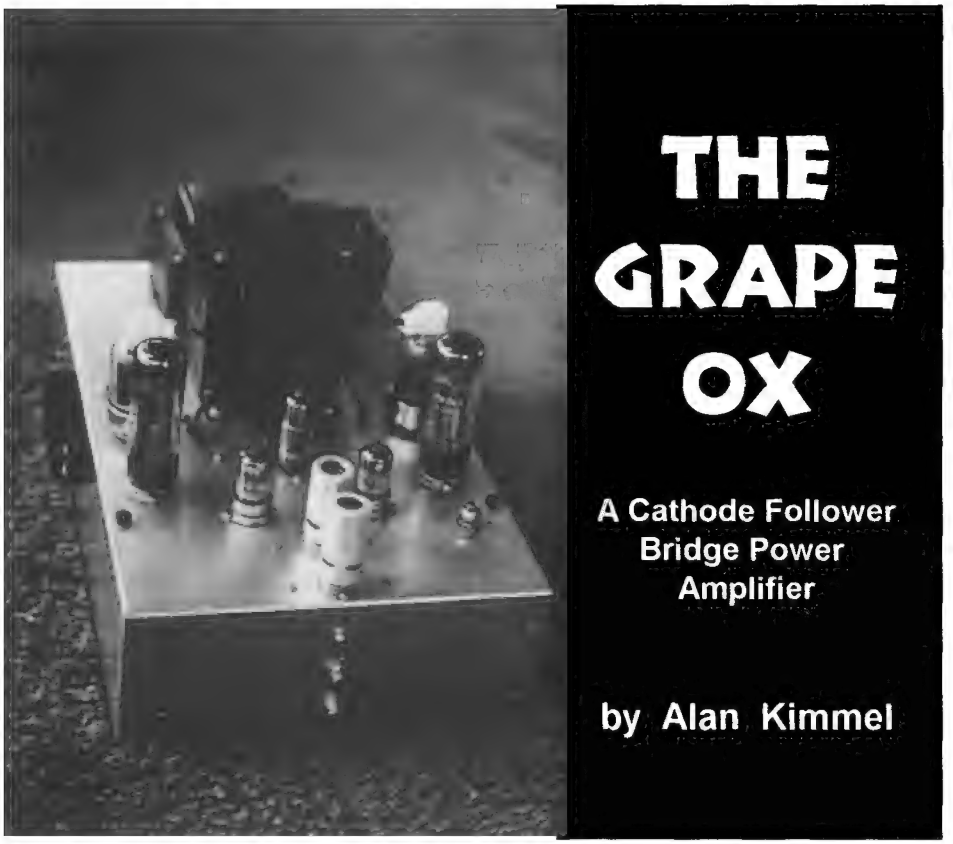


TABLE 1 - Parts List

R1, R6	100k ohm	R12	100 ohm
R5, R7, R11	1k	R13, R14	12k 6W
R2	470k	C10	.10uf 400V P
R3	68k	C2	1uF 400V PP
R4	22k	C3	1uF 630V PP
R8	68k 2W	V1	12AX7/ECC83
R9	50k pot.	V2	12AU7/ECC
R10	150k 2W	V3	see text

TABLE 2 Distortion for different tubes at V3 measured at 50V RMS output

V3	Distortion in dB 2nd	3rd	Drive mV for 50V out	Brand
EL34	-46	-43	141	Telefunken
EL36	-47	-74	65	Tungsram
5881	-48	-73	122	Sovtek
6L6GA	-45	-54	144	Tungsram
6AV5GA	-45	-68	82	Sylvania
6DN6	-47	-58	51	G.E.
6CD6GA	-39	-47	68	G.E.



THE GRAPE OX

A Cathode Follower Bridge Power Amplifier

by Alan Kimmel

Time for the PP Pentode Revival?

Like many others, I have been dissatisfied with conventional vacuum tube output stages, whether single-ended or push-pull. Without the assistance of negative feedback (NFB) they have too much distortion and their output impedance is high. Performance in other areas is poor also. I felt it would be ideal, sonically, if performance could be significantly improved while using zero or little NFB. Push-pull amplifiers are making a comeback and this article sets forth one attempt to improve the PP amp.

It seems also that some *SP* readers are prejudiced against pentodes. The myth that all pentodes sound bad is just that—a myth. Note that the first stage of the renowned WECO 91 is a pentode. Pentodes can sound good, even excellent, when used properly. Sometimes simply changing brands will make the difference.

The point I want to make is: HOW pentodes are used can make ALL the difference. Pentodes have gotten a bad rap that they don't deserve, partly because of failure to use them optimally and largely because of nothing more than hearsay/myths. The belief that *only* triodes can sound real is an oversimplification. Reality seldom conforms to our neat simplifications.

I don't say that pentodes are better than triodes, or vice-versa. I say, let's make the most of both. Rather than pitting one against the other, it is possible and desirable to allow them to work together synergistically. One application where pentodes excel is as cathode followers.

One of my main objectives was to obtain a low source impedance to drive the output transformer. This suggested a cathode follower (CF) output stage. I looked at CF amplifier construction articles from the past but most left something to be desired. After trying various CF output stages I tried an idea I've always wanted to try: a PP pair of "single-ended push-pull" (SEPP) output stages, each driving one end of the output xfmr primary, forming a bridge output stage (PPSEPP).

The idea of a bridge output stage is not new, e.g. Kerim Onder built one in 1954 using 6AS7 triodes in the output stage of an OTL amplifier to drive a 400 ohm speaker to 8 watts (*Electronics*, Feb. 1954). My CF bridge amplifier presents a refined variation of the concept.

Before further discussing the bridge output stage I want to mention something about conventional PP output stages. When signal is applied, an output tube conducts and pulls its plate down toward ground. At the same time, the opposite output tube conducts less and its plate voltage increases by the same amount that the conducting tube's plate voltage decreases. This see-saw effect is due to transformer action from one primary half to the other. In this process, the less-conducting tube's plate voltage increases well above the B+. In many conventional amps the plates can swing as high as 1KV or even higher. Also, current increases through the conducting tube's half of the OT primary while current through the other half decreases.

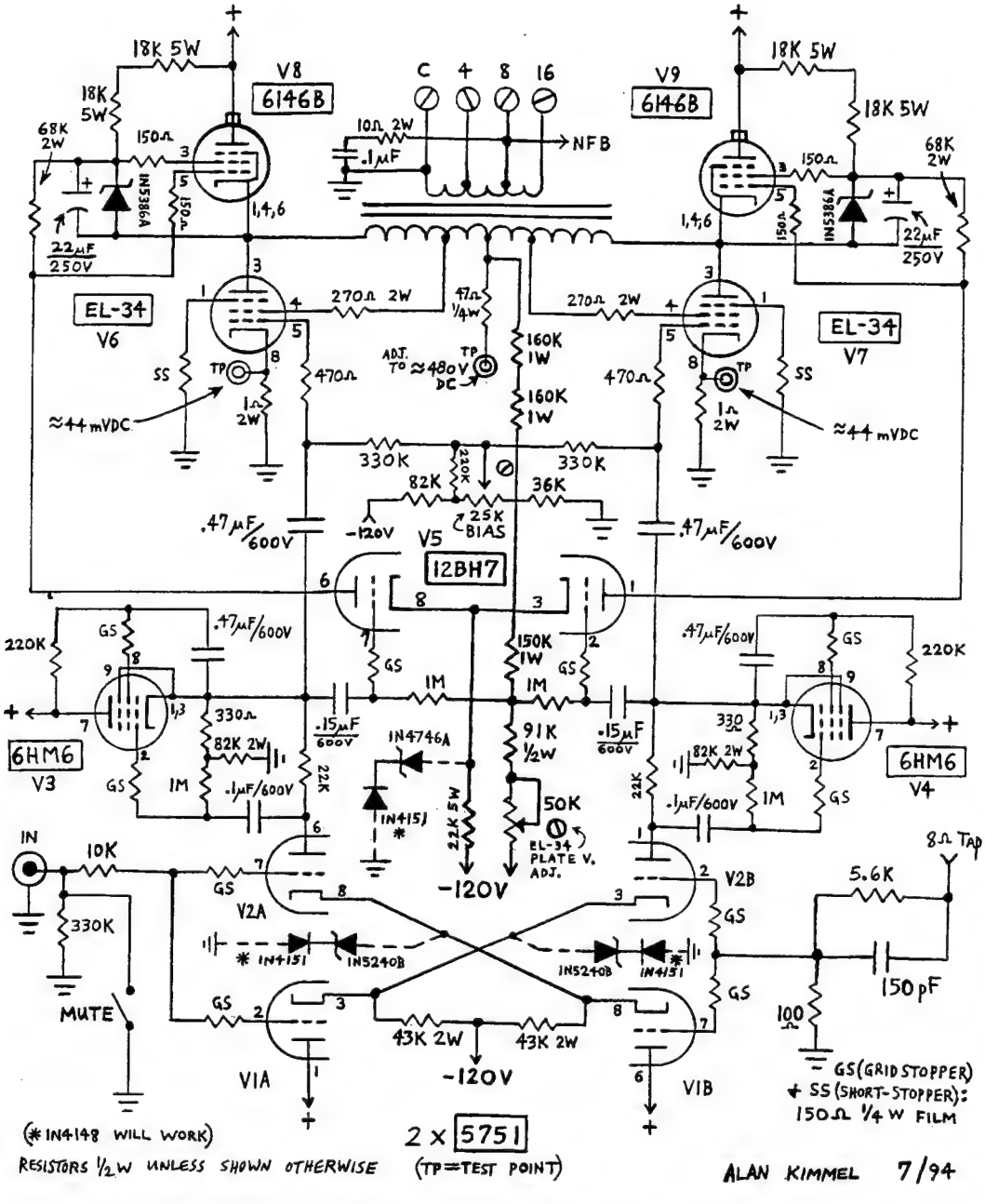
In a bridge output stage, both halves of the primary see equal current at all times with benefits such as prevention of OT saturation, reduction or elimination of PP switching transients, and good performance even without negative feedback.

Bridge Output Stage

In this amp the "bottom" pair of output tubes (EL-34s) are operating pretty much normally except that they are getting a lot of assistance from and are dominated by the "top" output tubes (6146Bs). In fact it is more accurate to say the 6146Bs are being helped by the EL-34s. The less a 6146B conducts, the more its EL-34 conducts, and vice versa. This ensures that a low impedance is driving the entire output xfmr primary all the time. The 6146Bs are the CFs of the output stage and the EL-34s can be thought of as active loads for the CFs. You could say the output stage is "dual push pull", i.e., a bridge output. Because the output CFs dominate the output stage, I call this a CF/Bridge output stage.

At first I tried straight CFs for the output stage—no bridge. The center tap of the output xfmr primary was grounded. I was able to get much more power with the straight CF output stage but it had a lot of crossover distortion with an 8 ohm load. To kill the x-over distortion the output tubes had to be idled at high current, a problem which apparently could have been dealt with by paralleling a lot of output tubes to share that current. The situation changed when I went to the bridge output stage. It could operate at significantly lower idle current than the straight CF output stage while keeping distortion down.

Fig. 1 — PP Cathode Follower Power Amplifier



A bridge output stage does not use the center tap of the output xfmr primary; thus the same current flows through the entire primary. Therefore, although the screen taps are used, it should be difficult, if not impossible, to saturate the output xfmr in this amp no matter how unmatched any output tubes may become.

At first glance it may appear that we are indeed using the c.t. of the output xfmr but a closer look will reveal that the c.t. does not connect to a source of B+. In this amp the c.t. serves only as a test point and as a convenient place to derive DC NFB. The DC NFB helps stabilize the quiescent plate voltage of the EL-34s which is helpful when the bias is adjusted or when output tubes or the 12BH7 tube are changed. The 50K pot is adjusted so that the voltage at the output xfmr primary is ½ the B+ (480 VDC in this prototype). Though the DC NFB reduces interaction between the voltage adjustment and the bias adjustment, they still might interact a little. When adjusting either pot you may have to go back and forth between the two a time or two. I like to use locking pots for voltage and bias adjustments.

Since this bridge output stage does not use the c.t. of the output xfmr primary, the usual voltage-multiplication found in conventional output stages is gone. To compensate requires a B+ equal to a little more than the peak voltage I want across the primary. In this prototype the total B+ for the output stage is 960 VDC, and the quiescent voltage across each output tube is ½ the total B+.

Radio amateur handbooks feature many transmitter construction projects with a B+ exceeding 1KVDC. A growing number of audio amplifiers are using transmitting tubes such as types 211, 811A, 845, etc. Those amplifiers often have a B+ exceeding 1KVDC so there's no need to raise an eyebrow over a comparatively modest 960 V. 450 V can rearrange your hair just as well as 1 KV. Nevertheless the proper precautions and high voltage construction techniques are required. This amp should be built ONLY by those who have had plenty of experience in working with such voltages. Ensure that all wires associated with the power supply and the output stage have insulation rated at *well over* 1KV.

When I began experimenting with the bridge output stage, power triodes (triode-connected EL-34s) were tried for the upper output CFs; this resulted in comparatively feeble output power and poor high frequency response. That situation could have been improved by adding a pair of CFs to drive the triode output CFs but I discovered a simpler and much better solution: Replace the triode outputs with power pentode CFs.

Though this deprived me of the joy of adding more tubes and parts, the pentode CFs gave more power and also provided significantly better HF response due to their lower input capacitance. When building a pentode CF it is best to use a pentode with low screen grid requirements. This rules out tubes like the EL-34.

The first tube I tried as a power pentode CF was the 6JN6, and it did a very good job, but its plate dissipation rating (Pd) is a bit low. I really wanted a low screen voltage pentode having a higher Pd than the 6JN6

but also requiring about the same filament current as the 6JN6. This led to the 6146B, which does a really good job. 6146s were used in audio amps by RCA, Altec, and other manufacturers during the '50s and '60s.

Incidentally, horizontal deflection output tubes work nicely for the upper output CFs; besides having low screen requirements, such tubes are high-perveance types, and make good CFs. In fact, at one point 6LF6s were tried as the top output CFs, along with 8417s in the bottom of the bridge. The 6LF6 + 8417 combo worked quite well. *Important:* Each upper CF output tube in this amp must have its own separate floating filament winding.

We tried triode-connected EL-34s for the bottom output tubes of the bridge also but the improvement obtained by connecting their screen grids to the screen taps was so great that we kept it that way. EL-34 anode-followers were also tried at the bottom; results were better than with triode-connected EL-34s but not as good as the partial triode ("ultra-linear") connection.

Making the bottom tubes constant current sources might be a good idea but was not tried; in effect the EL-34s are already acting as constant current sources for the 6146Bs.

Standard audio output tubes which require a relatively high screen voltage (like the EL-34) are best for the bottom half of the bridge. Overall, the best combination seems to be: power pentodes with low screen requirements for the upper tubes, and ultra-linear operation of standard pentode audio output tubes for the bottom section of the bridge. Additional improvement can be obtained by giving each upper output tube its own dedicated floating 180V screen supply, however the amount of improvement would probably not be worth the trouble.

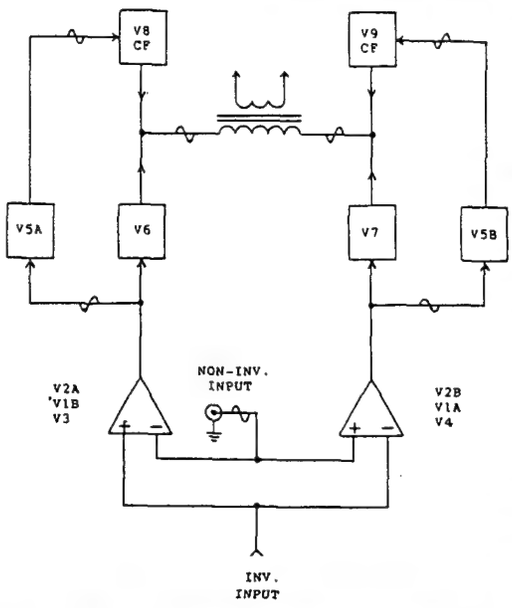
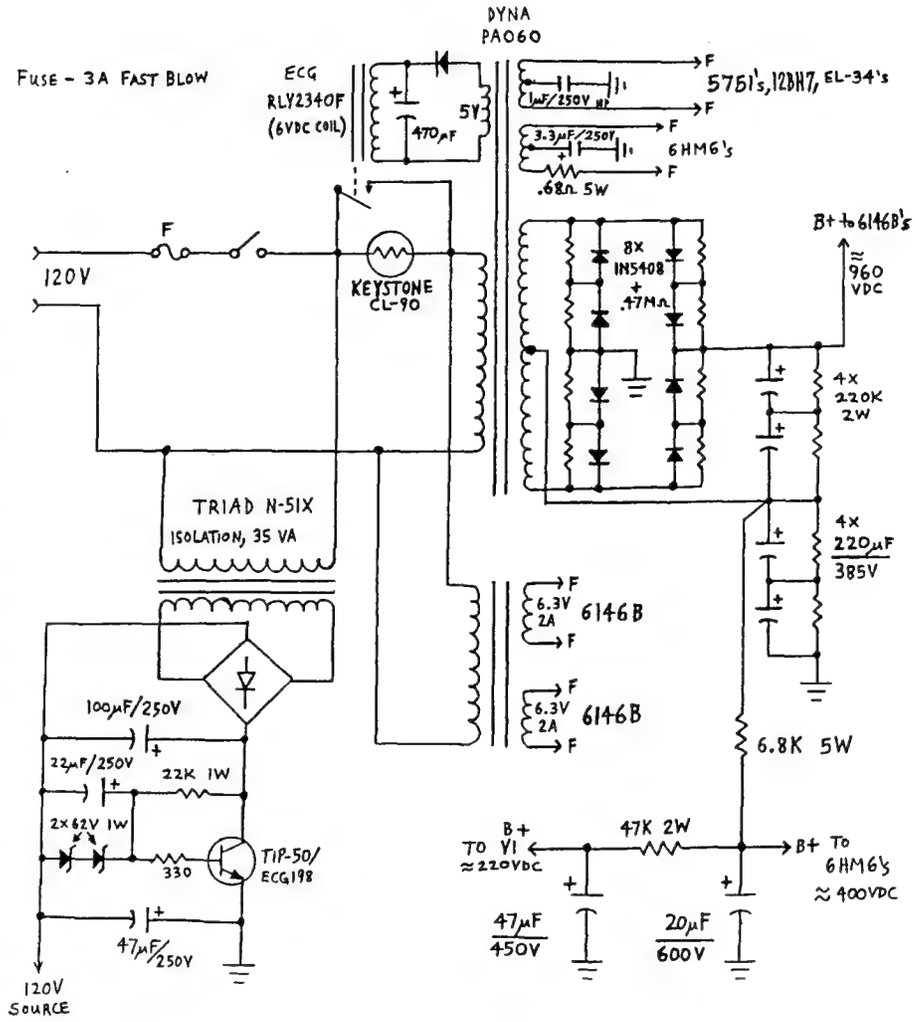


Fig. 2 — Block diagram of amp

Fig. 3 — Power Supply



About the only thing I did not yet try with the bottom tubes was to operate them in "enhancement" mode, that is, applying the drive signal to the screen grid (grid #2) rather than the control grid (grid #1). If properly done this should work well, provided an adequate gain ratio is reestablished between the bottom and top portions of the bridge.

More about the bottom tubes: the bottom output section (the EL-34s) has slightly higher overall gain than the upper output section (the 12BH7 and 6146Bs). This slight difference in gain provides best performance. This became even more evident when 8417s, which have higher gain than EL-34s, were tried at the bottom. The 8417s provided somewhat better performance than EL-34s but EL-34s were chosen because they are more plentiful. 6550s were also tried at the bottom. Performance was no better than with EL-34s and perhaps even slightly inferior probably due to the lower gain of the 6550. Other brands might make a difference but were not tried.

It's a shame to let the 8417 tube fade away. Its high gain can simplify many amplifier designs. And it would be real nice if somebody would manufacture a higher power version of the 8417 — they could call it a 9417. It could revolutionize high power tube amp design.

Perhaps this amplifier has a little more power than many of the readers of this magazine are into, but higher power has its advantages, such as less clipping and better ability to drive inefficient speakers.

Driver Stage

A CF output stage requires very high drive voltage. The high drive voltage needed for the output CFs, provided by the 12BH7, was easily obtained with Mu Stage type bootstrapping. Properly applied, bootstrapping can be a wonderful aid. Note that the time constant at the input of the 12BH7 should be identical to the time constant at the input of the EL-34s because the 12BH7 and EL-34s work concurrently, in unison. By the way, a 6BL7 might be ideal in place of the 12BH7 but I haven't tried it yet.

You could say this amp has a triode output characteristic because the 12BH7A dominates the output CFs and the output CFs dominate the output stage. The triodes are in complete control of the amplifier. The pentodes are but slaves of the triodes, acting primarily as precise extensions of the triodes in the amplifier.

The front end of this amp, consisting of V1 thru V4, is the dual diff-amp Mu Stage from Fig. 7 of my Mu Stage article (*Glass Audio* 2/93). It is simply two Fig. 6 diff-amps (from the same article) with their inputs cross-connected to get push-pull output. This front end (shown as two op amps on the block diagram) provides the phase inversion as well as voltage gain. V2 provides the voltage gain; V1, V3, and V4 are CFs. I could have used any kind of gain stage and phase inverter but I feel that this circuit is sonically superior to most other driver circuits, gain stages, and phase inverters.

The 6HM6s (V3 & V4) might be hard to find but probably most, if not all, of the tubes having the same pinout should work. (6JC6As were tried and they worked well.) V3 & V4 can share the same filament winding and it is best if that winding is used only for V3 & V4.

My favored approach to Mu Stage design entails having a pentode CF on top of the stage. One of my design goals, and one of the benefits of having a pentode CF on top, is that we have a gain stage that can deliver very large outputs; thus it is easy to make a Mu Stage that can deliver a pk-pk output voltage approaching the B+. This is one of the characteristics that make it ideal for use in power amplifiers.

Other equally important characteristics are good linearity, wide frequency response, and low output Z. The bottom half of the Mu Stage, a triode, sees a very high impedance load with extremely low shunt capacitance. Sonically, it's an ideal environment for the triode (a "triode in paradise"). A pentode CF is extremely transparent, very musical. The result is a very wide open window through which the triode can convey the music---the real goal of the Mu Stage.

I know some of you SE fans are prejudiced against *all* phase inverters. Yes it's true that many phase inverters cannot deliver a wide frequency response and low distortion at both of their outputs; often the performance of one output is far below that of the other output. This phase inverter, however, combines two very good driver stages; one is a non-inverting driver stage and the other a mirror image inverting driver stage. This circuit provides a high quality homogeneous push-pull drive signal to the output tubes, avoiding the sterile, pasteurized sound (and performance) of mediocre phase inverters.

This amplifier is versatile; if a single input and zero NFB is desired, the inverting input is grounded. If a balanced input and zero NFB is desired, the inverting input is used as the other input for a balanced line, in which case both inputs would use equal value input resistors. The third option is to use the inverting input for NFB as Tom Tutay and I chose to do.

If zero NFB is chosen, the gain of the amp can be set by the first two tubes at the front end, V1 and V2. If high gain is desired, plug in a pair of high mu tubes. For low gain, plug in a pair of low mu tubes. Because a properly designed diff-amp creates the same quiescent DC plate voltage and current regardless of the tube used, this amp can accept nearly any pair of dual triodes (but V1 and V2 should be alike). 6SN7s are highly recommended. Or a pair of 12AU7s or 5814s can be used. For more gain a pair of 12AY7s can be used, a pair of 12AT7s, a pair of 12AX7s, etc. Virtually any pair of dual triodes will work and will exhibit good linearity in this circuit.

After comparing the sound of the amp before and after NFB, we decided to install some NFB. The sound with zero NFB was very good, but adding 7 dB of NFB helped tighten up the bass a bit and improved overall focus. A little NFB was better than either zero NFB or lots of NFB. If you use NFB in this amp V1 and V2 should be high gain types. We chose 5751 tubes for V1 and V2.

Incidentally, to give an amp even tighter control of the speaker, connect your 8 ohm speaker to the amp's 4 ohm tap. With high powered amplifiers you can still get enough power even when connecting a speaker to a lower impedance tap.

This amplifier has low noise even with zero NFB. All B+ passes through CFs. None of the voltage gain stages get their B+ directly from the power supply; they get it through a CF. This is true of the output stage as well, ensuring good Power Supply Rejection. Thus all amplifier circuitry is isolated from whatever sonic signature the power supply may have. This contributes to the excellent ability of this amp to deliver music.

The prototype uses an Eico #32024 output xfmr by Stancor (from the Eico HF-89 amplifier) because a pair were on hand and we wanted to put those xfmrs to work. The lower source impedance of the CF/bridge output stage should make it compatible with a wide range of output xfmrs. Because the output xfmr carries virtually no DC current (except the screen current of the bottom output tubes), it seems that a low power output xfmr should be able to yield more power in this amp than in a conventional output stage.

The prototype's power xfmr is a Dynaco #PA060, made for the well known Dyna ST-70. Using a solid-state full wave bridge rectifier with a power xfmr that was intended for a push-pull rectifier tube will slightly more than double the DC output voltage. In this way, conventional tube amp power xfmrs can power an amplifier that has a bridge output stage.

I used the 5V winding of the power xfmr for a soft-start circuit. It prevents the big inrush current surge when the amp is switched on. Any amp with a solid-state B+ rectifier should have some sort of soft-start. In fact, most amps can benefit from soft-starting and the soft-start circuit used here is a nice and simple addition to the amp, besides putting the otherwise unused 5V winding to work.

Years ago I tried a similar popular soft-start circuit that used a 120 VAC coil relay, with the relay coil connected across an amplifier's power xfmr primary. That soft-start circuit worked, but as it went through its sequence the relay sounded like an electric saw, and was almost as loud; that didn't give me a warm feeling. I discovered that it calmed

down very nicely if a DC relay is used. The result is a well behaved soft-start sequence. This soft-start circuit can be used in any amplifier. The thermistor was suggested by Tom. A thermistor is indeed the preferred choice and saves space, but a fixed power resistor can be used instead, probably around 50 ohms @ 20W, give or take a few tens of ohms. The value of the resistor, combined with the load that the amp presents to the resistor, determines how long it will take the relay contacts to close. (If too large a fixed resistor value is chosen, the relay contacts will stay open too long or never close at all, overheating the resistor). Besides reducing start-up stress, the soft-start permits a fast-blow fuse to be used which provides more protection than a slo-blo fuse.

Ideally, a longer delay of the B+ would be obtained if indirectly-heated rectifier tubes were used to make up the entire B+ bridge rectifier. A minimum of three rectifier tubes would be required: one 5AR4/GZ34 plus two half-wave rectifier tubes (plus 3 separate filament windings). Though three more tubes would have certainly been merrier, I felt I should draw the line at 9 tubes lest someone think this is a tube tester doubling as an amplifier, or vice-versa.

Other Ideas

As with most amp designs, additional refinements are possible. Here are a few minor ones for this amp:

1) Optional "warm-up cathode clamps" (the diodes shown in dotted lines on the schematic) can be added; they cushion the grids of the diff-amps during warm-up and go open-circuit immediately upon warm-up. They're a good idea for any tube circuits that use a -Vkk supply.

2) Increase the gain of the DC NFB loop. One way to do this is to replace each 160K resistor with a 160V 1W zener diode. This should make the EL-34 plate voltage adjustment and the bias adjustment practically 100% independent of each other. (Using the 160V Zeners may or may not require a filter capacitor of about 1 μF from ground to the junction of the 91K resistor, the 150K resistor and the two 1 meg 12BH7 grid resistors.) We might do this in the prototype someday but the amp is stable enough as is.

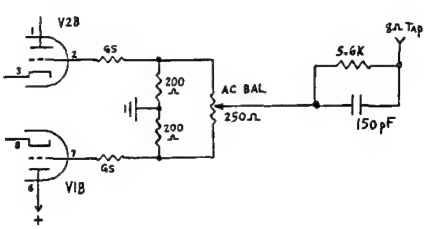
3) A special AC balance control can be added (Fig. 4). This can cancel any remaining distortion arising from whatever slight imbalance there may yet be somewhere. However, this amp is already quite good about AC balance and therefore an AC balance control was not installed in the prototype.

The mute switch is an option that's convenient for inserting or removing connections to the amp's input while the amp is powered up. This saves the amp the needless stress of being turned on and off each time input connections are changed. Because it is a shunt switch, it is completely out of the signal path when open, having no effect whatsoever on the sound. I think all amps should have one.

On the schematic, "short-stopper" resistors are shown at the suppressor grids (grid #3) of the EL-34s. In the unlikely event a short occurs from the suppressor grid to the plate, the SS resistor will blow and prevent a disaster. It's a little technique I like to use on any power pentodes that bring their suppressor grid out to a separate pin. Statistically this technique is unimportant, so if you prefer, connect the EL-34 suppressor grid (pin 1) to the cathode (pin 8).

Recommended current through each EL-34: 40 to 44 mA. (The current that flows through an EL-34 also flows through the 6146B on top.) When setting the bias a DVM is necessary to read the small voltage across the 1 ohm EL-34 cathode resistors.

Fig. 4 — AC Balance



This AC balance pot varies the NFB from one diff-amp to the other to increase the gain of one diff-amp while simultaneously decreasing the gain of the other. (In a Mu Stage, standard plate-circuit AC balance schemes are ineffective). AC balance pots are best adjusted with a distortion analyzer. Even a very unbalanced PP amp will probably have lower distortion than a typical SE amp. However, AC balance has more influence on distortion figures than on perceived sound. That's why I made the AC balance control optional.

The EL-34s are a matched pair. The 6146Bs should also be matched but this is not as important as matching the EL-34s.

A good CF amplifier from the past was designed and built by Mr. J.C. Witherspoon and shown in the January 1959 issue of *Audio* magazine. Mr. Witherspoon and I had similar objectives but we reached our goals in two very different ways. He called his amplifier "The Purple Cow", so I nicknamed my amplifier "The Grape Ox", which is easier than saying "The Cathode Follower/ Bridge Power Amplifier".

In conclusion, this amp is a bridge to great sound . . . an attempt to address inherent weaknesses of tube amps. It is stable and well behaved. A lot more could be done to further improve its performance before NFB. For example, it can be modified to accept 8417s at the bottom of the bridge and 6LF6s at the top, permitting a higher idle current in the output stage, which in turn would further reduce distortion and output Z. We stayed with EL-34s and 6146Bs because they are quite adequate for us. Still another possibility is to parallel the output tubes (PPSEPPP), which would also permit higher idle current in the output stage.

For Spec Inspectors . . . A Few Specs:

Zero NFB 1 kHz input, RL = 8 ohms:

8 ohm tap: Z_{out} ≈2 ohms
THD: The prototype measured: ≈0.06% 1W, 0.25% @ 10 W, 4.4% @ 50 W.

4 ohm tap: Z_{out} = 1 ohm
THD: 0.06% @ 1 W, 0.11% @ 10 W, 0.9% @ 45 W.

Noise: < 1 mV with shorted input.
Frequency response @ 5V rms output into 8 ohms: flat from 20 Hz to 20 kHz
Idle current for each output tube: ≈44 mA.

7 dB NFB 1 kHz input, RL = 8 ohm

8 ohm tap: Z_{out} = 0.8 ohm
THD: 0.04% @ 1 W, < 0.04% @ 10 W, 1.9% @ 45 W, 4:6% @ 70 W.

4 ohm tap: Z_{out} = 0.4 ohms
THD:0.03% @ 1 W, 0.04% @ 10 W, 0.43% @ 45 W

Noise: Lower than with zero NFB.
Freq. response: Wider than with zero NFB.
Idle current for each output tube: 44 mA.

Notes:
THD will vary depending on inherent linearity of V2, V5, and idle current of output stage. Different output xfmrs will of course affect the specs. Some xfmrs will yield better specs, while other xfmrs will not do as well. As readers of this magazine know, specs don't tell the most important story.

An excerpt from. . .

"THE TUBE PREAMP COOKBOOK"

by Allen Wright, Vacuum State Electronics

Will a component by any other name sound as sweet?

BUILDING BLOCKS . . .

*** A is for Air - The Insulator!**
Use it wherever you can: between components, cables, between cabinet walls and components, between everything! Don't get ridiculous and run 0 cm of wire between each connection but sometimes a little more (good) wire is better than unwanted interference and cross coupling. Use some air to get more "Air"!

It does sound so much better than any other dielectric — and it's cheap!

*** B is for Battery - and real DC**
There used to be a cult group in Melbourne (Oz) who used car batteries to supply the heater current for their 'X7 preamps, and they swore it was worth the hassle. And they also said if you had the charger in circuit when listening you were wasting your time...

Batteries in a smaller format can be used for tube bias, and there's a pix of such a usage in *SP* Vol. 1 #3, p. 26. And if you need a noise free source of voltage with very low source impedance, why not?

*** B is for Books - there are a few**
#1 - *The Radiotron Designers Handbook* by F. Langford-Smith. This classic book for tube people is an Australian masterpiece with so much data that you could never learn it all. My copy has lost so many of its outer pages I can't tell when it was published, but it's at least forty years old, and I'm sure there were editions out before the war. Long out of print, I found mine in a second hand book shop in Sydney one day when the sun was really shining.

#2 - *Vacuum Tube Amplifiers* by Valley & Wallman. These were the dudes at Bell Labs who amongst other things, invented the cascode circuit! This is the book to have and those Tek and HP guys must have carried it around in their hip pockets. It's the only source I know for the military driven tube applications research of the 40s and 50s! Out of print although I was told that it was being reprinted, but my promised copy hasn't arrived yet!

#3 - Tube Manuals
Any and all tube manuals from any of the tube companies: RCA, GE, Philips, Telefunken, Mullard Sylvania etc. The really interesting ones are the pro ones that cover special tubes, and they give all sorts of trick data you never find anywhere else.

*** C is for Cable - which is a book in itself**
Well I've got a book on the subject coming, and I'm not going to cruel my sales by giving you all the hot dope here. But here's a little of it.

The Guru shared these secrets with me one dark night, and I rushed home to try it out. Once again he was right and these are the key points he entrusted to me:

1. Audio signal cable must be solid core.
2. This solid core must be as thin as absolutely possible!
3. The material is not as critical as the thinness, thin copper is better than thicker silver.

Now this means what it says: 1.0 mm diameter (~18ga.) is better than 2.0 mm, 0.5 mm is better than 1.0, 0.25 mm is better than 0.5—and getting really crazy—0.125 mm is better than 0.25. There is no theoretical limit to this, thinner is better, sonically! This is wild I know and I would never try to put it on you if it hadn't been backed up by someone with some real credentials and pages of Math!

In an article printed in *HFN & RR* August '85, Professor Malcolm Hawksford did a brilliant examination of basic Maxwellian theory and how it applies to audio cables. And I think there was an even more Math heavy version in the *JAES* around the same time, if you're into that sort of self abuse.

The Prof. explains how cables really work for AC signals and for the first time anywhere gives scientific backup to what we've been hearing for years. And what he says fits exactly into what the Guru told me that night and I've since demonstrated to hundreds of mostly still disbelieving people. Thin cable bypasses the bandwidth restrictions and time smearing caused by thicker cables. It fits better into the requirements presented in the philosophy section and it sounds noticeably cleaner and less distorted!

Now I don't want to hear you bleating that you can't get good thin wire to try this out: Van den Hul sells 0.125 mm extruded solid core silver with teflon insulation, and that's what I use for myself. Audio Note offers 0.05 mm polyurethane 99.9% solid silver which seems about perfect to me and I'll be trying that next.

But for the cheapest good wire you can use, cruise down to your local Radio Shack/Tandy store and buy a reel or two of their 0.25 mm (~34 ga.) wirewrap wire. It's amazing, a silver plated copper with a 'strip-able' Tefzel insulation, for pennies a meter! I've used it for years and lightly twisted it has other uses...Whoops, that's saying too much...send off and get my *SuperCables CookBook*, it's less than the cost of a meter of 'the best' cable.

Now no freaking out on me, I know this thin cable idea is 100% opposite to what you've been told, read in all the glossy ads or seen on those huge cable spools in the HiEnd stores! But I heard somewhere that super cable is a four billion dollar a year business now, so how much profit do you think they'd make if they changed over to selling wire not much thicker than a strand of hair?

Could there be some misinformation in the air, do you suppose? Some subtle suppression of the truth?

Loud noises are heard from the back of the room, from the harassment group: "Yeah, but what about series resistance?" "If we make it too thin it'll just fuse!" "You can't work with wire this thin, it'll just break off in your hands!"

OK, OK, I hear you, but have you ever looked at the wire in your MC cartridge or the wire in a Jensen microphone transformer, or the wire in a $1000 AKG dynamic mike? That's thin, and yet they don't seem to have problems using it! And you don't hear of these items fusing, do you? Except

when some idiot plugs them into an output—and then plugs the cable from the power amp into the MC input! (The sound of the cantilever in it's death agony will remain etched in my brain forever...)

0.05 mm wire can take at least 50mA before it gets in any way stressed; so it will be fine most anywhere in a preamp. The series resistance is never more than a fraction of an ohm anyway, but it stays that way from DC to right out to beyond anywhere even you want to go! And it sounds sublime! Trust me, try it.

*** C is for Capacitor-**
A device from the Dark Side!

The only good capacitor is no capacitor, or so the story goes, and I'm inclined to agree. With the tube designers quitting before they figured out a PNP tube, capacitors are pretty well unavoidable in our units, so let's use as few as possible and then only the best.

I consider as a flat unbreakable rule that electrolytic capacitors have no place in any audio signal path, which means they have almost no place in a preamp. I'll only use them upstream of a SuperReg, and if you don't use such a regulator, with its almost infinite isolation between the AC and the DC, then there's no place for them, nowhere!

As cathode bypasses they're fully in the signal path and just horrible, and as + rail bypasses they are also 100% in the signal path, if you think it through. So straight out junk them! You want real music don't you? You want a least a chance at the 2 MHz/120db Audio Matrix! And do the same with Ceramics and Silver Micas. Nasty-nasty things!

"OK, smartass, so what do we use?" There are two schools of thought here: the Plastics and the Oilers. In each there's a pecking order and for Plastic, which is the team I'm familiar with, it goes a bit like this:

* Blue Caps/Green Caps/Brown Caps-these are your regular junker polyesters you can get most anywhere and occasionally you'll be surprised.

* Metallized polypropylenes (MKP) from the European manufacturers like Rifa and Wima are available up to 10F in a wide range of voltages. Wima MKP10s are those bright red block caps you see in all sorts of good(ish) gear and we'll use them in the low end Vacuum State products. They're OK.

* Foil/polypropylenes (FKP) from Wima, etc. Only available up to 0.22F, but now we're getting better.

* Foil/polystyrenes in values up to maybe 0.022F (22nF) from a variety of European manufacturers, Wima, Siemens, Rifa, etc. You can find these in 1% tolerance straight off the shelf here in Munich, and perfect for RIAA networks.

Beware, I'm talking about the modern single ended rectangular caps here, in pretty colors, with both ends of the stack fully welded to the leads and hence pretty much free of inductance.

But what people often use for EQ networks are the older (also 1%) tubular polystyrenes, that are clear and have axial leads, not from the center of the roll, but from 2/3rds the way out and are often known as Styroflex or Styroseal. Like the ones Audio Research uses in the SP6 and 8 for example.

They are considered perfect by most everyone, but these crappy little suckers are poison, and you'll do everyone a big favor if you trash them every time you see them. I don't step on bugs but I'll sure step on these sorry apologies for a precision component!! And because they have such a big rep on the street, you'd never consider them when hunting for that 'yukky-ness' that's become real apparent since you got everything else so clean!

The Guru once spent about a week, call it 100 hours, trying to get a preamp singing after I'd fitted these caps, and even he never thought of changing them... But after everything else was tried, he finally scrapped them in desperation and . . . Voila! Music!

* The specialist audiophile caps from Solen, Wonder, Hovland, Kimber and MIT etc., etc.... and not in any order of preference as each manufacturer has so many models and constructions.

* Then there are the really freaky Teflon and Glass caps, which I've seen pictures of, but never used.

Unfortunately I'm not about to say what's the ultimate best for all applications because I don't know, but the best I've used are the old Sidereal Caps, now replaced by the supposedly identical KimberKap.

But it's all so very subjective and I have a freak friend in Oz who swears the Sidereals steal about 50% of the information, and he'll only use brandless 'Blue Caps'.

The other big team playing on the capacitor field are the Oilers, who will not even admit to the existence of plastic caps. They can be seen praying to deadly old PCP filled relics, or swooning over the solid silver foil/paper/oil Audio Note specials that cost about the same as a good used BMW, and are used in the Audio Note amps that can cost more than a good new BMW!

And I'm not knocking them. In Oz we didn't have access to much of this exotica and I never thought to try old caps. Old tubes, sure, but old caps? Fair go, Mate!

So I've yet to try a good modern paper/oil cap but it's on the agenda and I'm hoping for magic things. Choose what you like, but use as few as possible!

*** C is for Chassis-**
But is that a component?

Wire, PCB traces and anything else carrying signal or power supply currents produce electric and magnetic fields of one form or other, and they will interact with any sheet metal in your chassis and cabinet and naturally, always in a non-optimum way!

If your chassis is made from some nonmagnetic metal (copper, brass, or good ol' aluminum) you will have less effects than with a magnetic material (Steel, Iron, Nickel) but the best thing to use from the sonic point of view is something totally nonconductive and nonmagnetic like our near perfect dielectric—Air!

Perhaps a little impractical if you have cats, kids or a wife, so the next best is a plastic, or some great looking wood. We put our production FVP2 preamp into a cabinet made from that super hard artificial wood used for speaker cabinets, and it sure sounded better than the same PCB with the same components mounted up in one of those 'off the shelf' steel rack boxes!

But even with one of these better materials, keep your cabinet walls as far away from the wiring as possible for the least interaction. Have you ever seen those little tweak gadgets sold to keep speaker cables up off the floor—same thing!

Also keep any PCBs well above the chassis, and if you're doing it right with 'Point to Point' wiring, keep the wiring and components clear of the chassis. But using the chassis as a genuine ground plane is a great alternate way to go and the best material for such a ground plane is copper, unless you already have your M3 (the BMW!) and then

you could use pure silver sheet (which is not as expensive as you might think), or at least have the copper silver plated.

Brass is the other option, it's much harder and stronger than copper and when really silver plated, and not just passed over some warm silver offcut, it's as good as silver plated copper, anyway.

More noises from the back, someone down there's getting pretty upset by all this unconventional engineering. Not at all what they did at the Old School: "But with all these non shielding materials, what about the HUMMMMMM?"

Good question, but even with no cabinet at all, if you really handle any earth loops in your wiring, there shouldn't be any hum pickup, and if you use a fully balanced design (keep reading) and also handle the earth loops, there will be NO hum!

*** C is for Choke - a forgotten device**

If you really want to filter your power supply, this is the tool! There's a point where you can't get any more filtering from capacitors, and the HF garbage will just float over the top of the big ones anyway, so get down and choke it out of existence!

Overheard one day: "Your filter choke should be as big as the transformer, or you've been shortchanged, Pal!"

*** C is for Connectors - a necessary evil**

Just like capacitors, the only good connector is no connector. And if you're really serious, why use any? Just hard wire the whole system together and a lot of your problems will go right out the window!

The connectors we use regularly use in audio are about the worst that could be designed, even if you sat down and thought about it. The guy responsible for the 'RCA' ('Cinch' in Europe) connector gave a bad name to a great ol' tube company and should have been boiled in oil, been made to listen to digital audio for ever, or made to listen to digital while being boiled in oil!

As a connector it does everything wrong! And the same thing goes for those #@&* DIN connectors! The XLR is better, but it suffers from the problem that the pins (while rugged and making a good contact) are too big in diameter to be a good match to the super fine cable you should be using by now!

The Lemo connectors used on the Mark Levinson equipment are really good, they are small and make a really good gas tight contact. In this day of high pollution, it's good to know your connectors are suffering less than your lungs.

The only problem with Lemos is: when did you last see a Lemo-Lemo cable for sale? Even at my local ML emporium, every Lemo connector on the back of the gear has a Lemo-RCA adapter plugged into it so commercial cables can be used. Rather defeats the purpose I would think, but I doubt if the average ML client could hear it anyway.

An inexpensive but great connector is the BNC used throughout the professional instrumentation and video industries. It's small, locking and 100% reliable, way better than the RCA!

Why couldn't that have been the standard? But if I was putting together a new 'built from the ground up' ultimate system and I absolutely had to put a connector in the signal path (note the use of the singular) I'd use one of those really neato subminiature UHF connectors that you see all over the inside of microwave test equipment (like 12GHz Spectrum Analyzers) and that look like baby BNCs—such as the SMB series. They use tiny connectors so the signal is impaired as little as possible, but they have moon shot connection integrity. Wonderful!

And what do these mil spec. marvels cost in these days of $60/pair RCAs packaged in a wooden box? How about $5.50 a piece? Five bucks for something that looks like it's been machined from a solid block of gold by Swiss watchmakers? Who's ripping who off here in our favourite toy shop?

*** G is for Gold - Warning time!**

The only change I would make to those SMBs would be to find some in silver (rather than gold) over beryllium copper, because silver's by far the best sonic solution for all audio connectors. Gold isn't the problem, it's the junk needed under the gold to allow it to plate to the base metal. Now solid gold might be cool...

There was a frightening story in *The Absolute Sound* many years ago from Doug Sax of Sheffield Records who changed his whole Direct to Disk studio over to gold XLRs, and then had to go through it all again to shift back to silver—cause the sound from the gold was unusable!

Now that's what happens when you take advice from Audiophiles and don't check it out for yourself first!

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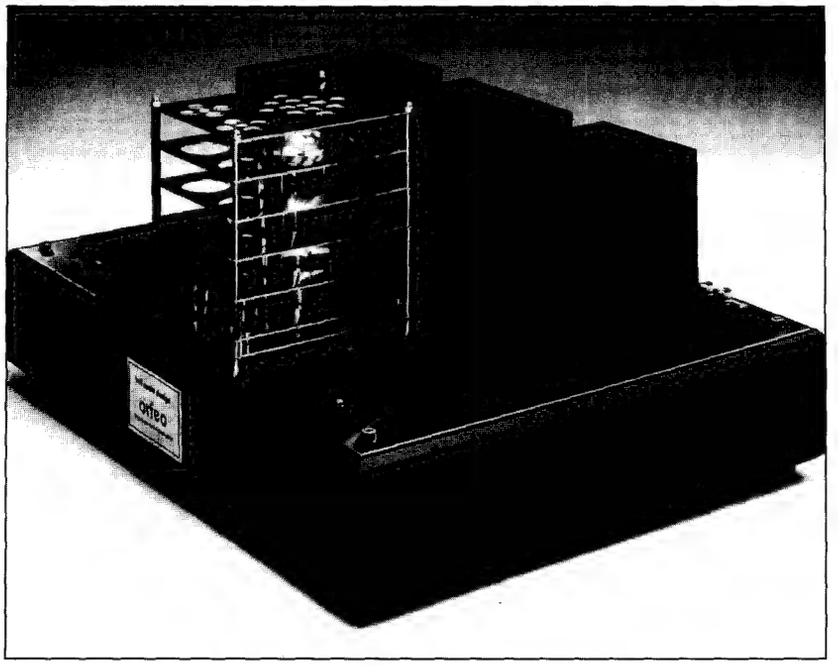
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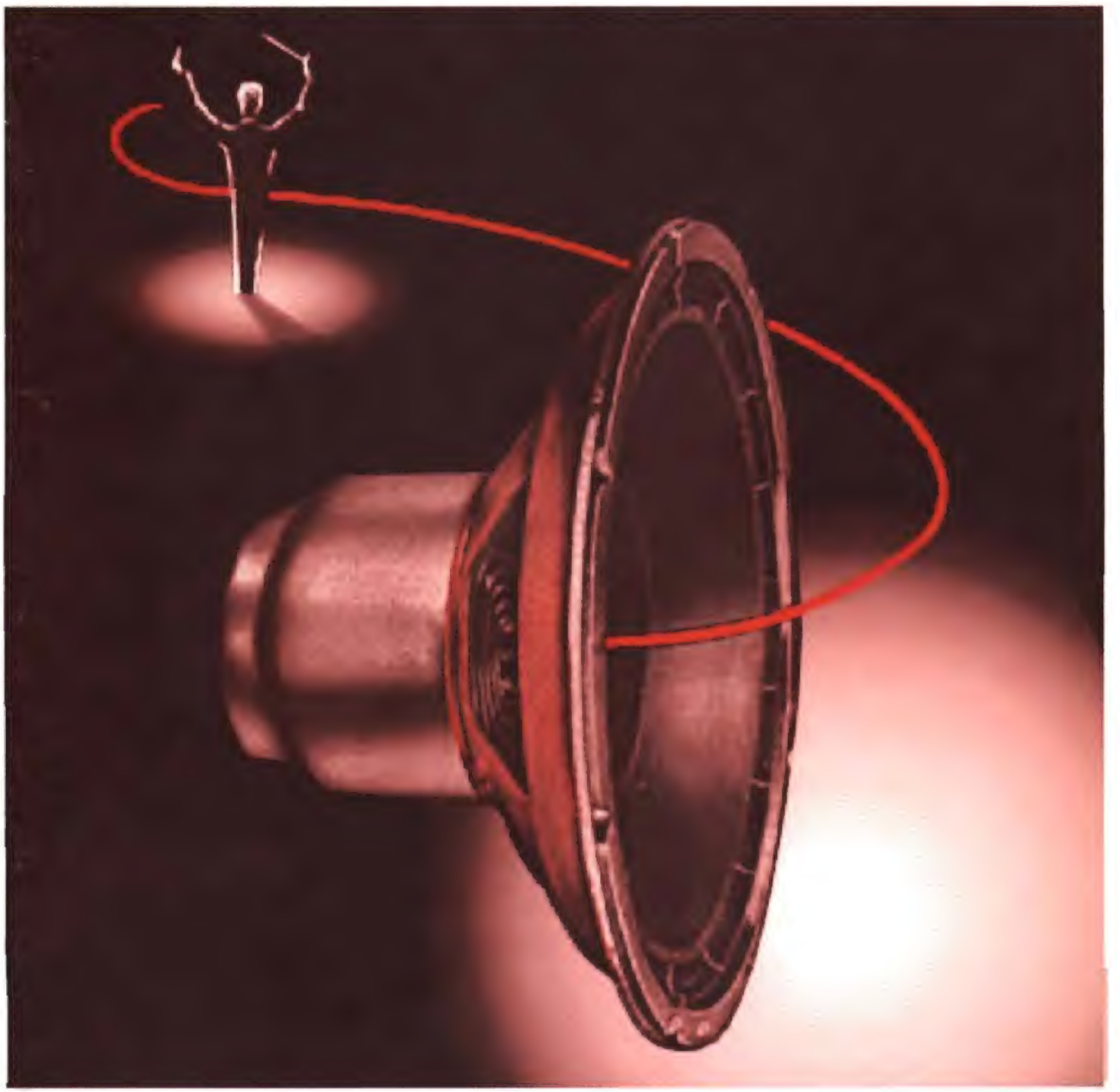
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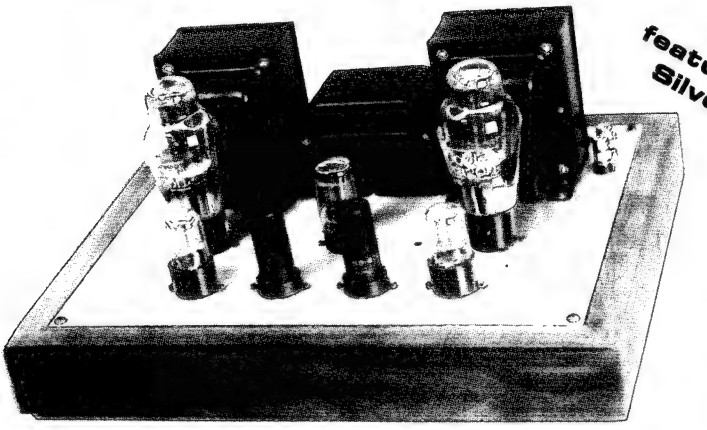
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The Grand Illusion

Way out on the paranoid fringes of contemporary American thought, miles beyond even the craziest audiophiles, there are some scared technology worshippers who believe that an international elite bad guy network of power-hungry conspirators has been conducting massively funded, wildly successful experiments with holographic imaging technology. The claim is that gizmos exist for creating 100% real-looking motion pictures in 3-D space, 4-D if you count time as a D. These infernal devices can materialize illusions that can pass through our senses as reality itself! *Yikes!*

The above-mentioned whistle blowers are trying to warn us that fancy hologram projectors will play a central role in the ultimate power grab in all of human history, planned to go down at the turn of the millennium. Over the generations, many predictions were made about the year 2001, the dawn of the new Aquarian age, and in five years we'll be there. The sinister plot intends to take full advantage of all the symbolic weight we loaded onto the coming of the 21st C as a weapon against the mind.

Imagine the effects of a totally realistic 3-D holographic motion picture show of the Virgin Mary descending from the heavens directly above the field where the final match for the World Cup is being watched by billions on TV worldwide. Then a fleet of UFOs flying in formation is spotted by 100,000 tourists over the Washington Monument fifteen minutes before the 4th of July fireworks display. Elvis comes out of hiding. Bill Clinton starts blowing tenor like Eric Dolphy. Vinny Gallo delivers the Altec 755A + cabinets he borrowed from me "for a few days" back in 1991. The impossibilities are endless. After a few weeks of this kind of virtual unreality programming, our belief systems will be mush. World societies will be flung into chaos and the tyrannical monsters with the projectors will rise to global domination—or so the story goes.

What I want to know is what do these schemers plan to use for speakers for this megascam? I don't think they can pull off a convincing soundtrack with Bose PA speakers and Crown amplifiers. Or Avalons and Krells, or anything else that I ever laid ears on. Would you believe an end of time show that rolls off at 50 Hz with a bit of squawk in the midrange like an Altec A7? How about an array of eighteen Wilson X-1 Grand Slams powered by Cary 805s suspended between two black helicopters? Nah, those diabolical New World Order cats better have something really hot up their sleeves, not just run-of-the-mill Recommended Components List junk.

Although audio brand names bow to the concept of the grand illusion we're all seeking to achieve, not even the best audio gear can truly deceive us into thinking we are *there*. None of this stuff sounds absolutely real, really. Even at its best, it's just a tease. Reading all the self-congratulatory prose in the glossy mags studded with loaded terms that don't permit argument or room for improvement — *accurate, neutral, transparent* — one would think that designers own the mysteries of music. Properly taken, terms like "accurate" don't permit gradations. Either it is or it isn't, so far it mostly isn't. Real sound is pure romance at our current level of practical know-how.

I'm not saying that it doesn't pay to set high goals, only that it is not productive to convince yourself that you're sitting under a tree drinking iced wine in the promised land when you're really still out in the desert sucking on a dry rock. Religious metaphors are appropriate here, because like other esoteric cults the High-End offers a menu of unquestioned articles of faith, arcane language, idol worship, crusades that nobody else cares about, anointed priests, and obscure ritualistic practices. Consequently, for average music lovers, a typical high-end product review is about as readable and relevant as Hare Krishna mythological epics. Indeed, attitudes and preferences which come naturally to music lovers enjoying their music are often loudly condemned as heresies of a high order among the Holy Knights of the Soundstage. No wonder so many non-audiophile music players and listeners think high-end audio geeks are just a bunch of clueless arrogant jerks with extra-loud stereos.

Maybe over the course of the next millennium, we will learn how to fashion audio systems that we won't have to study hi-fi magazines to appreciate, sound that everybody will instantly grasp, reproduction that imperceptibly dissolves into reality itself not some fake-science definition of "transparency". If the Aquarian Age brings us 100% real audio, *then* start worrying about the creeps with the hologram projectors. For now, let's just work on creating systems that can at least play music.



Raven Ribbon Tweeters

Recognizing the swelling popular demand for top quality high sensitivity drive units, ORCA is now importing the French-made Raven ribbon tweeters. Historically, ribbon drivers have been good-sounding but inefficient devices. Today's new neodymium alloy magnet materials permit ribbon transducers with very high sensitivity ratings. The spec sheet on the Ravens warns that if the magnets of two drivers are allowed to come into contact, it may be impossible to separate them! Furthermore, the super-light ribbon element of the Raven is pure conductive material (no metalized film) with 1/30th the mass of a dome tweeter!

R1 specifications

Sensitivity	95 dB/W/m
Frequency Response	2kHz - 45kHz
Impedance	6 and 12 ohm taps
Size	92mm H x 80mm W
Weight 1.14kg	Price $196

R2 specifications

Sensitivity	98 dB/W/m
Frequency Response	2kHz - 46kHz
Impedance	6 and 12 ohm taps
Size	92mm H X 80mm W
Weight 2.22kg	Price $340



Raven R2 Tweeter

ORCA
1531 Lookout Drive
Agoura, CA 91301
818-707-1629 voice
818-991-3072 fax

Marchand Vacuum Tube Crossover

The XM26 Tube Electronic Crossover is a fourth-order constant voltage crossover design that provides both low-pass and high-pass outputs. The slope of each output is 24 dB/octave. Because of the fourth-order design, the high-pass and low-pass outputs of the crossover are always in phase with each other.

The XM26 uses four 12AX7 tubes in each of the two channels. It has a solid state regulated power supply for both plate and filament voltages. The power supply employs automatic sequencing to protect the tubes from turn-on surges and to insure long tube life.

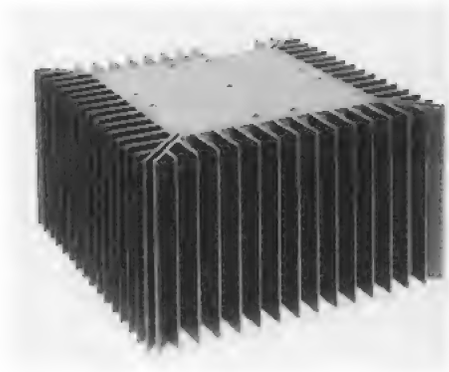
The crossover frequency of the XM26 can be set by replacing frequency modules. Crossover frequencies are available from 20 Hz to 5000 Hz. Normal slope is 24/dB constant voltage (Linkwitz-Riley) but modules for first, second, and third order slopes are also available.

The front panel features four calibrated level controls, one for each low pass and high pass and for left and right channels. A summing switch allows the low pass channels to be summed for use with a common subwoofer. A two year warranty covers everything, including the tubes. Priced at $599 each. Frequency modules (4 required) are $9.95 each.

Marchand Electronics
PO Box 473
Webster, NY 14580
716-872-1960 voice
716-872-1960 fax
phil@marchandelec.com
http://www.marchandelec.com

New Developments in Silicon SE

Following on the heels of the well-received Aleph 0 power amplifier, Pass Laboratories — undisputed leader in transistor SE amplifier design — recently announced October availability of the new 30 watt Aleph 3 stereo unit. With the Aleph 3, Pass hopes to make high quality single-ended transistor performance accessible to the average mainstream enthusiast. Suggested retail price is $2000.



Pass Aleph 3

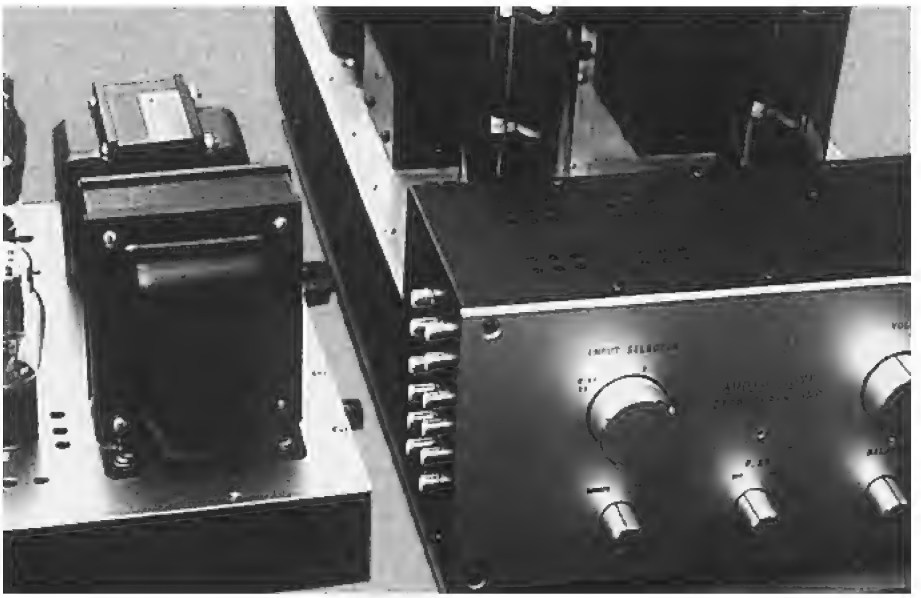
Each channel features two gain stages: one input mosfet and an output stage consisting of paralleled power mosfets with a current source. Along with some of his comrades in the tube camp, designer Nelson Pass advocates simplicity and purity in the gain path as a recipe for pure sound. Like all Class A amplifiers, the Aleph 3 runs a bit on the warm side. Generous heatsinking is provided to prevent injury and assure long component life.

Pass Laboratories
21555 Limestone Way
Foresthill, CA 95631
916-367-3690 voice
916-367-2193 fax

Yo, where's the WE 300Bs???

Westrex Corporation recently announced that the long-awaited release of the new production Western Electric 300B is currently scheduled for mid-November. The proposed breakup of AT&T into three separate companies will have only a minor impact on the tube and production work at Western Electric Kansas City Works is making significant progress, according to Charles Whitener at Westrex.

The reintroduced WE 300B will be manufactured in the USA at AT&T facilities using original tooling and the same materials, engineering specifications, and manufacturing processes of the original units. Existing WECO warehouse stock of NOS materials, such as a proprietary filament alloy derived from a 1963 melt, will be utilized in the new tubes. Bernard Magers, senior engineer of vacuum tube production at WE since the 1950s, provided valuable input on the tube and he will remain with the project to help ensure the highest quality standards.



Build the "Baby Ongaku" by Frank Reps

No relation, actually . . .

What nerve! Another ignorant scribbler writing in an audiophile magazine, rhapsodizing about a tiny 2A3 single ended amplifier and having the audacity to compare it to the peerless Audio Note *Ongaku*.

You may be tempted to think the author of this article never even saw a real live *Ongaku* let alone listened to one. Well, dear reader if you think that, you are wrong. Not only have I seen the *Ongaku*, the real thing is sitting on an equipment stand in my living room atop a Mark Levinson 31 CD transport, a 30.5 Mark Levinson D/A converter as well as a twelve year old McIntosh FM tuner (still as good as ever).

This seventy-pound boat anchor of a 211 amp is flanked by a pair of 1981 manufacture British Lowther TP1 enclosures furnished with the latest PM2 "A" Hi Ferric drivers.

This system is heaven to me and to most people who experience it. The *Ongaku* has no subtlety — it is colorless to a fault and it reproduces *all* of whatever signal is on the software. The Lowthers do have a very slight coloration, but to anyone who has spent any time listening to their crystal clear presentation, other speaker systems sound either like synthetic sound boxes or speakers with heavy blankets draped over their grille cloths.

I called my amp project "Baby Ongaku" because the end product is very close to the real thing sonically. The Baby is physically smaller, and much lower in power — 3 watts for the 2A3 vs. 15+ W for the 211-based *Ongaku*. This project puts the lie to the idea that one must spend $50,000++ to obtain sound quality on the level of the purportedly best amplifier in the world. If you use high efficiency Lowther speakers, this three watt amp will produce three times the power needed for a moderate-sized listening room.

Details and nuances of the music are reproduced to an incredibly realistic level by the "Baby". I think it's because of the silver Magnequest transformers. All of the top level Kondo-designed Audio Note amplifiers use pure silver transformers, so I don't think the similarity in performance is accidental.

Oxygen free copper wire has about 94% of the conductivity of pure silver and one would think that a six percent difference could be compensated for in some way by the transformer designer. The cost differential is astronomical and what is six percent anyway? I have no physics class explanations of why silver sounds as it does but I do know from experience that well-made silver transformers provide a more transparent presentation and seem to pass on more of the detail contained in the program material than copper wired ones.

This is the "silver sound". The "Baby" has that sound. I have quite a bit of listening experience with the Audio Note *Neiro Silver* (silver caps) as well as the Audio Note Limited Edition *Kageki* (a *Neiro* with silver output transformers). All of these are great amplifiers. The *Kageki* is probably the best Audio Note of Japan product ever, even better than the *Ongaku* if you can live with seven watts output. There is definitely a silver sound and some of the best amplifiers I know of have it.

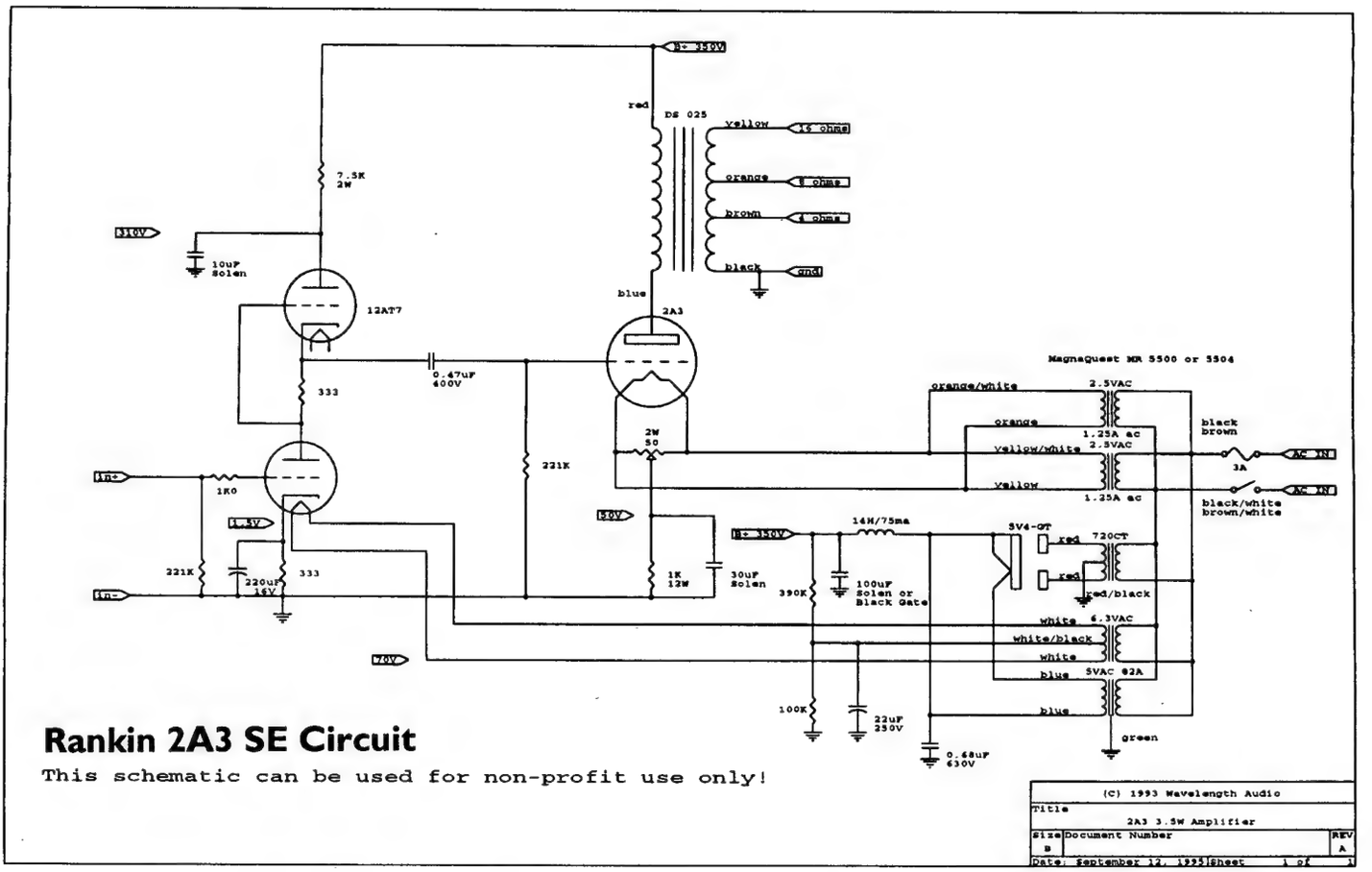
Even if one had the money the Audio Note Japan products are limited production items, hard to obtain, and outrageously expensive. *If* you can afford them, I would argue that the Audio Note amplifiers are a *necessity*, but from any pragmatic point of view Level 5 Audio Note products are a senseless way to waste money. The "Baby Ongaku" on the other hand, is well within the reach of any serious minded audiophile. But, if you want one, you must manufacture it yourself!

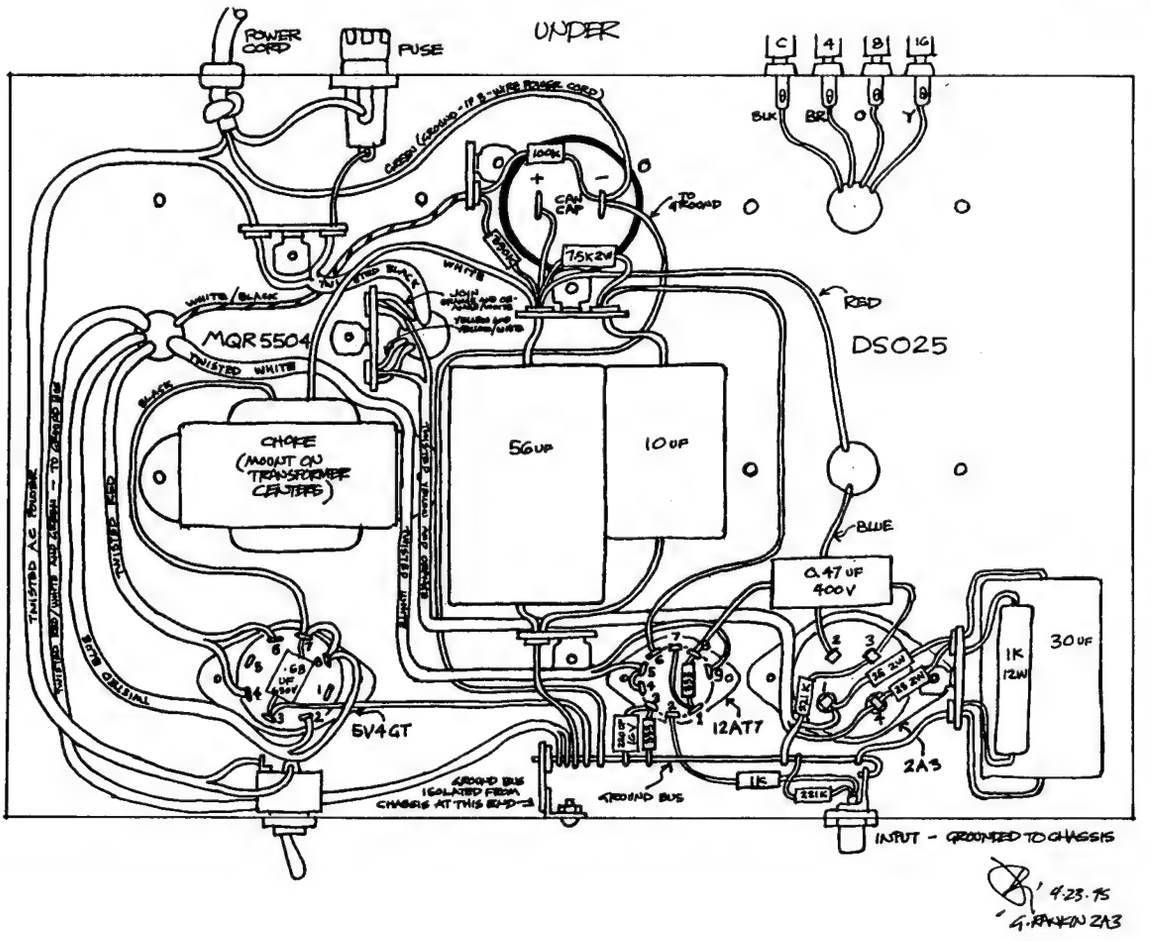
This "Baby" amp came into existence somewhat in the same manner that the classic film *Casablanca* came together. I think a committee of ten made the movie. Even though *Casablanca* was a cut and paste job, it metamorphasized into a great classic film.

A committee of four just happened to get together to make this particular amp. A random series of events took place that resulted in the "Baby". This amp too was sort of a cut and paste job.

A few months ago, I was talking to Mike LaFevre (the manufacturer of Magnequest transformers which are now captivating the hearts of Japanese audiophiles long used to the high quality Tango and Tamura products) about Ducati motorcycles and Alfa Romeo cars when the subject of a really neutral, clear sounding low power SE amp came up.

He told me that Gordon Rankin of Wavelength Audio, designer of the rave review *Cardinal* 300B amps, had recently provided him with a very simple 2A3 amp schematic which he made public for non-commercial use. Aside from the 2A3 output tube, the amp uses a single 12AT7 SRPP driver and a 5V4GT rectifier tube. A few tubes and a handful of capacitors and resistors is all there is to this simple circuit. Word "on the street" was that people who built Gordon's 2A3 thought it was a great sounding amp project, so I decided to give it a go.





Notes on layout 2A3 SE amp

Mark and lay out chassis first, then mount all iron and hardware. The layout given requires 4 double lug terminal strips and three single lugs. All lugs used for circuit connections must be isolated from the chassis ground.

The *only* connection to the chassis ground is through the ground bus at the input jack. The other end of the ground bus must *not* make chassis contact. Use thick wire for the ground bus. All AC leads must be twisted as indicated by thick lines on drawing.

Good luck and no cold solder joints.

Don Garber



Mike sent me a copy of the schematic and after a lot of head scratching in an attempt to draw out a decent wiring diagram, I finally gave up and contacted Don Garber of "Fi" fame. He's the man who builds the exquisite direct coupled, silver wired 2A3 amps that have audiophiles on the East Coast captivated. Don Garber is probably one of the most meticulous and detail oriented amplifier builders in the country. I gave Don the mechanical layout and he proceeded to produce the simple and elegant wiring diagram illustrated which he agreed to make available as a gift to the *SP* readership.

Since I am an admirer of Audio Note of Japan products, I asked myself: Why not "ape" some of their construction details? This necessitated a 50 thou polished copper plate on the top of a black semi-gloss chassis. I used Solen filter capacitors as specified by Gordon Rankin and Black Gate capacitors in all other areas. But most importantly, I used the pure silver wire Magnequest output transformers and as much silver internal wire as needed.

In order to make the amp as solid and bullet proof as possible I utilized a Hammond aluminum chassis size 8" x 12" x 2". I cut out the top of the chassis leaving a one inch border along the sides. This would be the bottom of the new amp. I then took a sheet of 50 thou solid copper 12" x 9" x .050" and bent it at a 1" 90° angle along the 12" side. The 1" bend would serve as part of the ground plane where the input RCA socket and off/on switch are located. This plate would now be the top of the chassis fastened to what used to be the bottom of the Hammond box, got it? The back of the alloy box houses the AC socket and speaker output posts.

Before I go any further, these "Baby Ongakus" are not cheap. To make them properly you will be spending $1,600 for two Magnequest silver DS025 output transformers and an additional $300 for a pair of Magnequest power transformers. Count on spending several hundred dollars for the Black Gate caps and tantalum resistors as well as a couple hundred or so for the Hammond chassis boxes, silver hook up wire, speaker binding posts, Solens, etc.

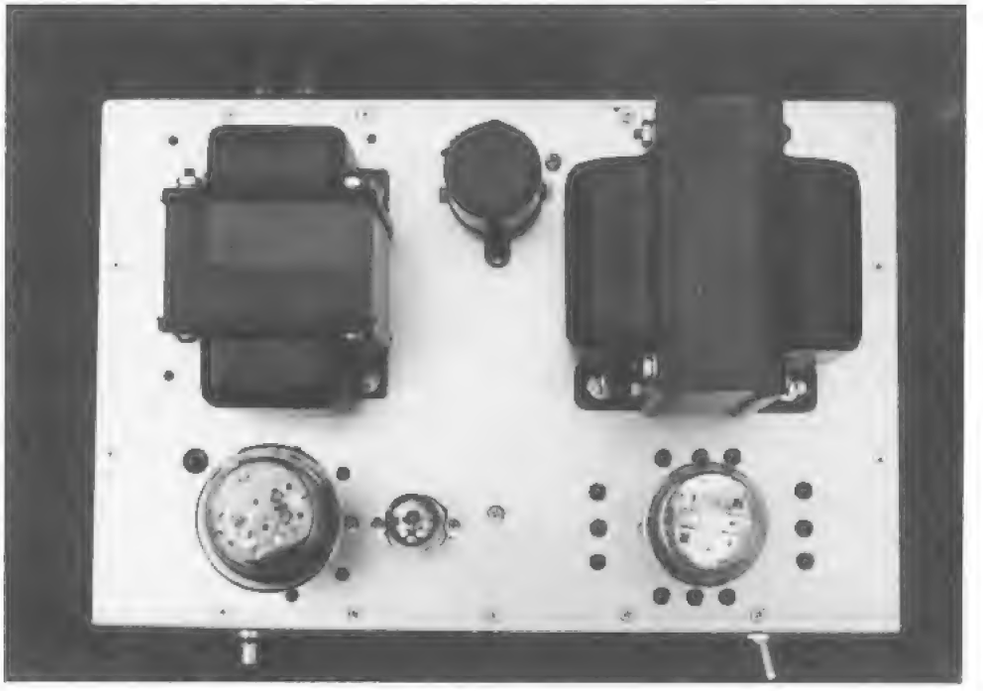
Let me digress. . . if any of you are *serious* music lovers who want to capture the rare and wonderful, emotionally satisfying experience obtainable from the "Baby Ongaku", the cost is very reasonable, even if you have a journeyman amp builder construct it. For you others, you *dumpster divers*, you *garbage night alley scroungers*, you *garage sale commandos*, and all of you who are reading this copy of *SP* in the form of a Xerox copy produced on someone else's machine, let me make one charitable attempt to enlighten you. Hey, this advice is FREE so glom onto it.

Always remember these fundamental facts of life that apply to all of Man's existence:

"Good things are not cheap!
Cheap things are not good!"

Any fool who seriously thinks that he or she can conjure up a "Magic Amp" with a few dollars worth of surplus parts, an old car radiator, and a $4.98 Weller soldering iron should put this magazine down right now! Drop it, Fool! Take your 59 cent hamburger and plain wrap soda pop and retreat to the friendlier environs from whence you came.

Go back to the land of four year old *Popular Mechanics* magazines, room temperature IQs, and your dusty "I coulda/shoulda/woulda" projects. Go back to your dear friends who still believe that the 300 mile per gallon carburetor is being suppressed by Big Oil Companies.



Top view of "Baby Ongaku" amplifier

I personally think that the publisher of *SP* should refuse any and all articles that re-hash cheap and silly circuits and go over long-disproven theories. Our primary focus should be the search for the highest level of reproduced musical excellence, a level only obtainable by the use of vacuum tube technology (particularly single-ended topologies) in conjunction with the most efficient loudspeakers available, single point source if possible. I'm talking about the "less is more" philosophy carried to its highest level.

Depending on the degree of finish you wish to impart to your amp, it may take some time to construct. I used 6-40 aircraft blind nuts for the bottom plate fasteners. The top plate is fitted with recessed flat head 4-40 stainless aircraft grade machine screws using locking nuts. The photos and illustrations give you an idea of constructional details.

A most important aspect of construction is the ground buss. Use a #12 solid copper wire, wrap the ground end around the threaded portion of the RCA input socket and then put the nut on. Solder this with a high wattage gun after it is tightened down. All wires go to the ground as illustrated in Don Garber's drawing. I used a 25 watt 1k cathode bias resistor for the 2A3 bypassed with a 30 uF Solen cap and placed it in a central position on my chassis. For a coupling cap, I chose the copper foil-in-oil Audio Note and they sound really great.

Do not bend any of the wires at right angles. Use gentle bends when routing the wire. Let the Magnequest transformer leads be as long as possible. They do no harm being long. Make sure the copper top plate is fastened as securely as possible.

Don't use sheet metal screws, use machine screws and nuts. The rigidity of the chassis will have an effect on the sound. The stronger and more rigid the chassis, the less chance of spurious microphonic noises.

The output tubes should be matched highest quality Chinese Golden Dragon 2A3s or NOS RCA, Sylvania, etc. The driver should be the Mullard manufactured 12AT7 equivalent or top quality Golden Dragon. The 5V4G could be NOS RCA but the Sovtek 5V4GT is an acceptable and available alternative.

Do your voltage checks and then plug in the tubes. Before you do any serious sonic evaluations be sure to let your creation burn in for a week or so. Don't ask me why, but at first the amp sounds as if you are listening to a set of headphones laying on the carpet with the volume turned up. After a few hours you will begin to hear some music shine through. I can't explain the break-in phenomenon, but within forty hours or so the amplifier will begin to give you a hint of what is to come. My suggestion is to play a tuner through the "Baby Ongaku" out of earshot for a couple of weeks before any serious listening.

You now have a pair of expensive to build 3 watt monoblocks, equipped with silver output transformers that taken alone cost more than many complete amps. What you also have is a close approximation of the "silver sound" produced by the Audio Note *Ongaku*. No it does not replicate the undefinable *Ongaku* quality of absolute silence and space between each precise nuance of the music. However, it comes so close to that undefinable *Ongaku* quality that unless you make a direct comparison to the *Ongaku* you probably won't miss the difference. Use the $50,000 savings for a Porsche instead!

One of these days Mike LaFevre will start pricing his transformers at levels comparable to the Audio Note UK silvers (not as well made) or the Japanese Kondo manufactured silver transformers (unbelievably well made) and your opportunity to own a "lifetime" amplifier will have come and gone.

The previous issue of *SP* contained plans for the classic Lowther *Acousta 115* enclosure. It is worth the trouble to have a pair built, believe me. Form a co-op and get your friends to pool their talents and make those enclosures. They will reproduce music. They're not "hi-fi" speakers. The "Baby" will work perfectly with the Lowthers. In fact, it's a match made in heaven.

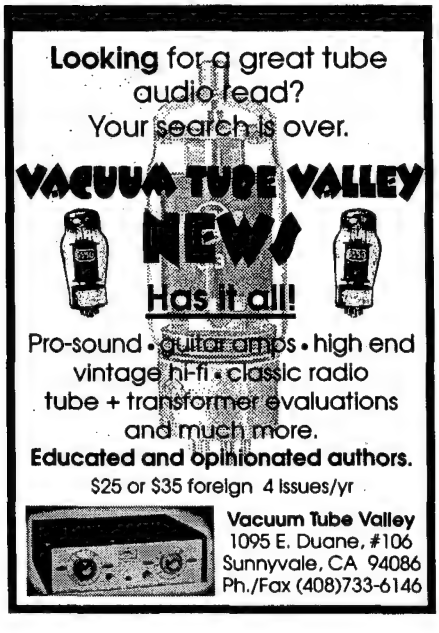
If you've been trying to get realistic sound from some of the ludicrous but highly touted multi-way particle board horn systems using crappy European drivers, or if you went the "Radio Shack" way and mounted a bunch of "Quam" and "Pioneer" speakers in your own unique enclosure you may be ready for the Lowther Acousta *115* enclosure with even the least expensive Lowther driver. Build the cabinets, hook up the Rankin/Magnequest/Garber/Reps, et. al. 2A3 Silver SE "Baby Ongaku" and prepare yourself for a radical change in direction as an audiophile.

Your new focus will be on accumulating records and CDs and transport mechanisms, D/A converters, turntables, tone arms and cartridges up to the task. The "Baby Ongaku" and the Lowther speaker systems won't need upgrading. Your investment in time, money, and labor will yield music reproduction in a league with the best available at *any* price.

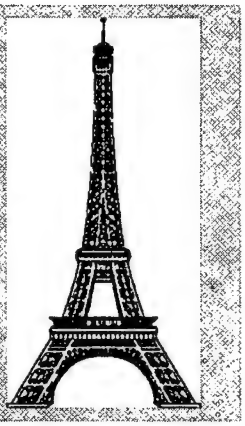
Notes from designer Gordon Rankin

The 0.68 uF cap can be varied to establish the 350V B+ to the specified value. The power transformer secondary plate is shown as 640 ct in this particular circuit. Make sure that all voltages are correct before attaching speakers and tune the 50 ohm pot for minimal hum. If using 6A3/6B4-Gs, I suggest trying a DC supply with large amounts of capacitance in the power supply (10000 uF or more) to avoid hum problems. You can play around with the coupling cap. The value should be between 0.22 and 0.47 at 400V or higher. I found that the 0.33 uF Hovlands sound really good.

Many constructors have built this amp with no problems using only the schematic provided above. If this is your first time, I suggest that you find someone close by who can help you with the details. I will accept comments and requests for help by e-mail ONLY: waveaudio@eworld.com. Enjoy.



MONSIEUR RANKIN's EURO SELECTION



by Gordon Rankin, Wavelength Audio

Yet more pro bono work from the explorateur at Wavelength.

Aside from the obvious requirement for reasonable sensitivity, speakers that work well with low power triodes usually have a well tempered (untemperamental) impedance curve. It really helps if the x-over uses a simple first order network so that power is going to drive the speaker not the network.

Perhaps it is because most American designers opt for higher order networks that I find I usually prefer some European models which present an easier load to a tube amplifier. On a few occasions I worked with series x-over networks and I found that they worked better than the standard parallel networks, though they were harder to develop.

My current favorite commercial speakers are the Swiss-made Reference 3A Royal Master Control (US importer Fanfare Int'l 212-734-1041). They are two way systems featuring an 8" driver and a partially horn loaded tweeter. The 3A uses no crossover on the bass/mid driver and two resistors and one Hovland cap on the tweeter. Wiring is Siltech silver 22/2 (appprox. 15 ga.). They are rated at 93 dB with an impedance that doesn't dip below 7.8 ohms and they sound great with my 300B amps. Aside from the Reference 3As, I suggest that owners of my 300B amps be sure to have a listen to Spendor 71 and QUAD ESL II (both from QS&D 800-659-3711) and also the ProAc Response 1 & 2 (US importer Richard Gerberg 410-486-5975).

The only vintage speaker I have had good luck with is the WE/Altec 755A, maybe because this full range cone driver requires less tweaking than multi-way systems. I used a 1.8 cu ft cabinet with the 755A with two Scan Speak Variovents to extend the LF a touch. Although these ancient, impossible-to-find speakers are great in the mids, they lack bass and high end. Other vintage components may have potential but I get frustrated with all the work necessary to get them right.

For a DIY project I recommend making speakers that are foolproof. Keep it simple, like a two-way with an 8" and a 1" dome tweeter. There are a few interesting Cabasse drivers that look good on paper, specifically the DOM4 tweeter at 96 dB and the 21M18 Woofer at 93 dB sensitivity. The woofer is good out to 5 or 6 K. Zalytron offers some kits using these drivers. Unfortunately the crossovers are hogs, but you can buy the drive units and cabinets and work on the x-over yourself. I personally don't like the sound of D'Appolito configurations or multiple driver arrays. Like I said, keep it simple.

LS 0/65 Single Driver Single Ended Partner

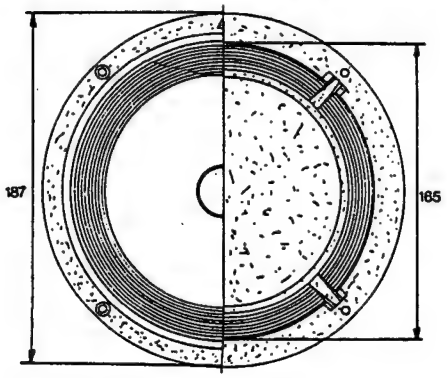
Looking over all of the drivers on the market for the last few years, I was discouraged since most require elaborate cabinets or complex correction circuitry. I began hearing good things about the Triangle T17FLV 608 paper cone 5 inch full-range drivers so I faxed France and bought a pair. The T17FLV 608 is rated at 94 dB with a range of 50-18 kHz. so it appeared to be an excellent candidate for a triode amp partner. What's more, this unit works real well in a simple to tune and construct slotted or ported design.

The Triangle drivers are now distributed in the US market by ORCA, which is a good thing because they can provide the basis for a reasonably priced, non-time consuming, near-foolproof efficient speaker project.

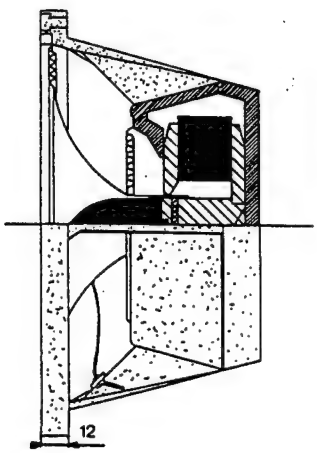
I built speakers for years back in the early 80s when I had access to great test equipment in college. I even designed a test fixture for the DEC VAX 11/760 for my senior project. After school, I got bummed out with speaker projects because testing can take forever. Luckily there are some great PC and Mac packages to help steer us modern speaker craftsmen through our explorations. I used the new Audiosuite software from Liberty Instruments, mainly because it was cheap, it does the job, and Bill Waslo lives here in town.

I also downloaded some programs from the Madisound BBS to calculate the cabinet sizes. The T17 FLV has a resonance of 49 Hz, nominal impedance of 12 ohms, and it is 94 dB efficient. With a Qt of 0.41, the volume of a ported enclosure needed to be 1.8 cu. ft. I used the Woodstyle WS123 cabinets for my 755A experiments and I remembered that these were just the size I needed. For this project, I used the new slim line (12" W X 13.75" D X 24" H o.d.) version.

Diameter 107mm
Power max 40 W
Efficiency 94 dB/W/m
Resonant frequency 49 Hz
Nominal Impedance 12 ohms
Min. Impedance 10.2 ohms @ 300 Hz



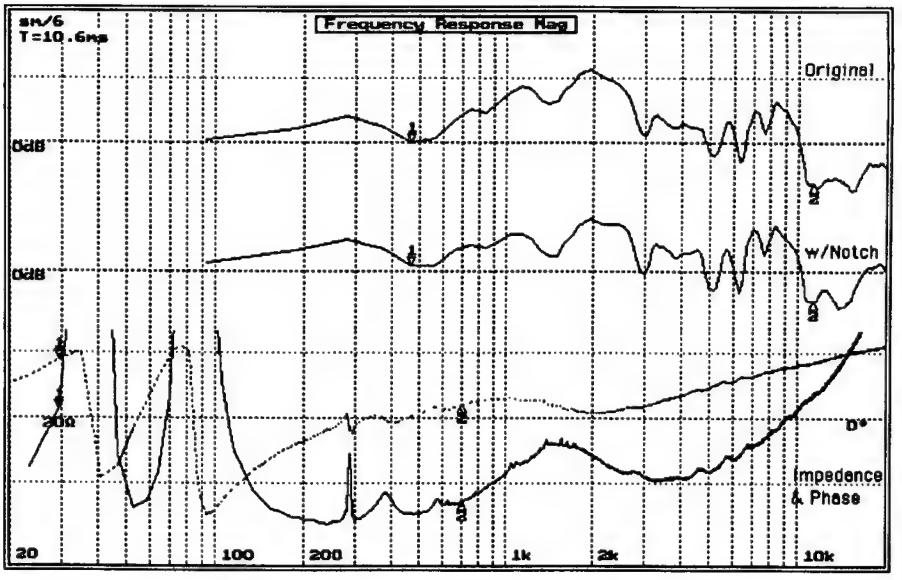
TRIANGLE T17FLV 608



With a 1.8 cu. ft. cabinet and a box resonance of 52 Hz (-3 dB point), I came up with a port size of 4" round and 4.5" long. Using the Audiosuite setup, I was able to adjust the port equal to the resonance frequency empirically. The optimal port size determined by measurement wound up very close to the calculated results at 4.375". There was a slight rise in the output of the driver at 2 kHz that was up around 5 dB higher than the mean of the response curve. I wrote a program in "C" on my PC to determine the appropriate notch filter for that frequency. I came up with 20 uF in parallel with a 6 ohm resistor and a 0.5 mH inductor.

Using the frequency response plotter in Audiosuite, I tuned the filter by varying the resistance and capacitance. The EQ sounded and measured best with a 5 ohm instead of 6 ohm resistor and with a paralleled 0.22 uF Hovland across the SCR 20 uF capacitor. As you can see from the impedance plot, the notch filter centered around 1.75k instead of 2k. I think it sounds better with the filter because the main irregularities in the response shift down to the less offensive <2k region, aside from having a flatter response overall. The minimum impedance of the system is 11.9 ohms at 240 Hz with a mean sensitivity of 94 dB. Perfect for your SE amplifiers.

This speaker plays realistic bass down to about -3 dB @ 50 Hz. The highs are a bit attenuated but what's there sounds very good. Overall, the sound quality of the LS 0/65 in on a level with many of the high quality commercial speakers I have heard. The nicest thing about the speaker is the midband speed of the crossoverless driver. Also, this design avoids x-over distortion problems that usually accentuate driver mismatch in the upper midrange.



Measured response and impedance plots of author's LS/065 SE Partner. Note smoother overall response with EQ filter installed (lower curve).

Construction is easy. Buy the following components:

SCR 20 uF / 630 V caps
Hovland 0.22 uF / 600V Musicaps
Sidewinder 0.5 mH inductors
5 ohm Mills MRB12 or Lynk 20 W resistors
Triangle T17 TLV 608 drivers
Woodstyle WS123 narrow cabinets
Spectra Dynamics Deflex pads (4 total)
Silicone (100%) sealant
Your favorite cable

Cut and route the driver holes and the duct. Install Deflex pads directly behind the driver and at the top of the cabinet above the driver. This will help clear up any cabinet resonances. Install the driver 8" from the top of the cabinet to driver center and install the port 8" from the bottom to center.

I think you will be very pleased with the performance of this simple, low resource drain project. After listening to these oneways, I have a better appreciation of why audio purists have always searched for the perfect single driver loudspeaker. A single cone and a nice triode amp can yield some fine musical enjoyment.

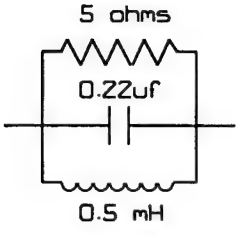
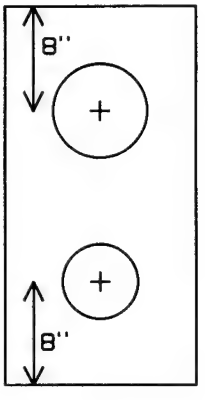


Diagram of notch filter/EQ network. Mount in series with the positive speaker lead.

Usual set-up configuration is with driver on top and port on bottom. However, if using high stands, try inverting the cabinet to get the driver down to ear level for your listening position. Experiment with placement for best balance.



Vendors

Madisound Speaker Corporation
PO Box 44283
Madison, WI 53744
608-831-3433 Phone
608-831-3771 Fax
608-836-9473 BBS 8/N/1

Zalytron Industries Corp.
469 Jericho Turnpike
Mineola, NY 11501
516-747-2515 Phone
516-294-1943 Fax

ORCA Design and Manufacturing Corp.
(Triangle importer)
1531 Lookout Drive
Agoura, CA 91301
818-707-1629 Phone
818-991-3072 Fax

SPEAKing OUT for SE



by Scott Nixon, Anodyne

Love American Style

First off, support American products, or as close as you can get, when it comes to the purchase of your store bought fancy dude speakers. Most of the small time imported European fare costs double or more what it should, with half your money covering shipping, weak dollars, and high importer markups. Readers in the ECM should do the inverse, or import more American goods while the dollar is down.

As will be shown below there are incredible values available from manufacturers in the US that offer much more for your real dollar. It is also time to be slightly wary of efforts to squeeze your juke-box-money with sham products that promise to be 'SE Ready'. Not long ago it was 'Digital Ready' speaker hype we had to put up with. So, look out for dumpy 15" 2 way jobs with fake EV 8HD horns or towers of thousand dollar '98db' hype. Sensitivity isn't everything. Caveat Emptor Rules.

New Designs — Real Finds, No Fluff!!!

KRK You got a modest sized room? How about a pair of 7" 2 way compact monitors that will fit on 20-24 inch stands and are 92 dB sensitive. As an audiophile you expect to spend what . . . $3900? . . . too much? Well take back $3451 and spend $449 for a pair of K-RoK monitors from KRK. These come in a gray speckled finish and would look great in both Fred and Barney's groovy sound dens. Wilma and Betty will love the size and it matches all their furniture too. K-RoKs were designed for nearfield home studio monitoring and are quite revealing little guys and certainly not mid-sucked mindless robots. If these were built by an audiophile producer, they would be gloss black and two thousand dollars. Find these at pro sound dealers that handle recording equipment. Think of these as a low cost fast and bulbous 'BBC type monitor' for the hungry SE masses.

METAPHOR A new model speaker, Metaphor 5 offers an 8" 3way floor standing, small foot print design that is 93 db sensitive. The current retail is $3450 but these also feature unique and beautifully crafted enclosures. They do dip to 4 ohms in the bass region, but ain't dat what th' dadburn 4 ohm taps 'fer? These offer a lot of value and better sound than most smaller, lesser performing imported products. The SE user is exposed to mostly full range, almost e-stat sound, that is virtually wartless.

The Metaphor 5s kind of remind me of an upscale sonic DNA crossing of an (please excuse the comparison) Avalon, B&W and Quad, but overall better, and they are drivable with most good SE amps. The Metaphors will definitely show up weaknesses in amplifiers of slack too. Overall, I'm pretty impressed.

Both of the designs above barely meet *my* minimum sensitivity criteria for a 7-8 watt 300B based amp. Both should work very well in modest rooms (12x15 to 14x18) if you can live with moderate playback levels. Speakers with 90 and below sensitivity should be home auditioned in big time audio party mode before plunking down cash. Play some solo female vocal, solo piano, small Gothic choral groups, and big sound symphonic pieces. If you don't clip the stew out of your amp on this music you're more than likely okay. It's mostly the sustained complex harmonics that clip your amp into the low sens. speakers. A lot of OTLs have similar limitations.

But there is a way out, and it won't hurt for very long. Think of the next speakers as a modified 12 step program to de-program your stereophule mindset. Bubba, you been remanded to Sensitivity Training . . .

K-Rok Personal Monitors

Two way mini-monitor designed for home recording studio use.

Response	57Hz-19 kHz +/- 3 dB
Sensitivity	92 dB 1w/1m
Impedance	8 ohms nominal
Crossover	2.5 kHz
Size	14" x 12" x 9.75" HWD
Finish	Grey texture
Price	$449/pr.

KRK Monitoring Systems
16462 Gothard St., Unit D
Huntington Beach, CA 92647
714-841-1600 voice
714-375-6496 fax



Metaphor 5

Three way system with each driver mounted in a separate tuned enclosure within a rigidly braced cabinet.

Amplitude response	35Hz-22kHz
Sensitivity	93 dB/2,83V@1m
Impedance	4 ohms nominal
Size	39" x 11" x 15 1/4" HWD
Finish	Natural cherry/black grille
Price	$3450/pr. (standard finish)

Contact info:
Metaphor Acoustic Designs
15390 Twin Creeks Court
Centreville, VA 22020
703-815-0082 voice
703-815-2939 fax



HERESY For too long Klipsch speakers have mostly gotten a bad rap. The whole line has been castigated as a rowdy boy's white trash party sound. The Heresy and Forte II are 97 and 99 dB and with 7 watts these will blast. If you have heard either of these with any amp other than a high quality SE thang (including PP tube amps), forgetaboutit.

Simply put, these two relatively affordable models are the 'Vandersteen' equivalent for the SE toting crowd, with a most decent benchmark sound and the appropriate SPL factor. At $400-800 used these will clearly outperform a lot of the Johnny-come-lately big SPL sham boxes that are begging for your attention. Instead of the juicy sucked out midrange death of a lot of audiophile-approved designs, certain Klipsch models really dance and sing, even with a few tiny watts.

Admittedly, Heresys are not the highest resolution design in the world, but they can get you started using SE without power limit angst. Be creative with setup of Klipsch and avoid the dreaded dead-on-axis position. Heresys are spazmatic to set up. Here are a few things to try: You can use the built-in plinths if you converge the center axis 3 to 4 feet in front of or behind your butt and, in a big room, the stage occurs at normal height. A favorite setup at the Anodyne megaplex has been 16" stands and flat up against the wall pointing straight out, a la Linn Sara. The boundary effect is great for the bass and you won't get the wallpaper soundstage effect.

Fortes need 10 or 12 inches of elevation. Try a couple concrete blocks. Fire them straight out and keep away from boundaries.

One option worth serious consideration if you like the Heresy concept but you are looking for something a step ahead comes from Gillum Loudspeaker Systems in Ridgedale, Missouri.

People who have heard them insist that Gary Gillum's g3 speaker is a much better sounding design than the Heresy and based on these reports, I consider them to be a must audition. These carefully handcrafted units are NOT a copy of the K design but an affordable (under $1500) speaker that is in a similar format — 12" + mid and tweet horns — using better drivers and horns than the current issue Heresy.

As with all of store-bought Plug 'n' Play speakers mentioned above, it's totally your personal choice. Remember just because you read about something in a good-looking slick magazine, does not make what is said true and does not make that product the best, or the worst compared to anything else.

This is a hobby, it's about illusion, and the reality is, for most publishers, only about advertising revenue, not your sound, not your music.

DIY Roll your own 8" 2 ways are pretty easy to do and you can find 92-94 dB Focal and Davis drivers that will roll off on their own. Then you add in a tweeter at 6 to 8 kHz. Simple, easy to drive, but hit or miss without some way to test them.

Fortunately, testing has never been simpler. New software to turn your PC with 16 bit Soundblaster card into a powerful FFT jammin' Spectrum analyzer can be had for 50 to 200 American dollars. But even so, unless you do your own woodwork, to buy drivers/enclosures, etc. you land around $350 for something that might be great or might really reek. All DIY projects are a gamble, none have much resale, and you could buy KRK or used Klipsch for a few dollars more and have a known entity. That said, *you* decide how you want to proceed.

Gillum G3 Loudspeaker

Horn loaded compression driver midrange and tweeter with a direct radiating 12" woofer, featuring high efficiency and high output power.

Bandwidth	50-Hz-17.5 kHz +/- 4 dB
Sensitivity	97 dB 1W/1m
Impedance	8 ohms nominal
Crossover	750 Hz and 6.5 kHz
Size	23 1/4 " x 14 1/4 x 13 5/8 HWD
Price	$1100/pr.

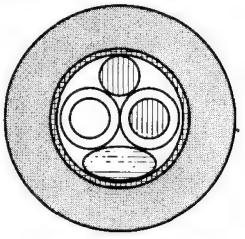
Contact Gary Gillum at
Gillum Loudspeaker Systems
PO Box 123
Ridgedale, MO 65739-0123
417-334-7428



Silver Sonic

High performance audio cables

"With tube amps and hybrids, the Silver Sonic competed with the best," Bound for Sound, No. 4/95.



Model BL-1 Interconnect: $95/1 meter pair
Model T-14 Speaker Cable: $3.95 per foot

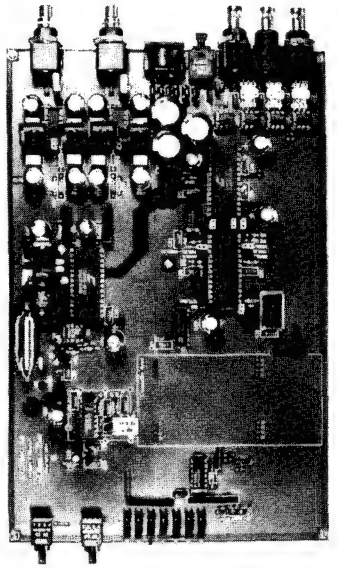
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Write for detailed information

Audio Crafters Guild

5102 East 38 Place
Tulsa OK 74135 U S A

Now you have some tunes while you expend efforts to build your ultimate Big Dog system. You will find the whole process much more enjoyable with decent SE sounds to entertain you, while you quest for more fire. Ugh, big sticks = more fire!

Big Dog Horn Rigs

Now we think about Edgar midhorns and biamping and big bass thangs and start breaking the normal audiophile code of conduct. With horns try to always use higher than first order filters, second order and up will lower out of band distortions and squelch diaphragm resonances, especially in bullet tweeters. First order is too easy, it works for direct radiator designs, but it is a cop-out, offering many problems when used with horns.

There are projects from the early 80s in *L'Audiophile* that combine Onken boxes with time aligned Audax 7" and Fostex tweeters that are direct radiating 100db designs that are quite good. This would be a raw parts cost thousand+ dollar project, and most big designs will be at this price level or even much higher.

Pro Sound Most of the offerings from most manufacturers are great for your typical lounge lizards or rockin teenage combos but are boom and sizzle audio death boxes for your home hi fi. High sensitivity and lumpy response curves are the norm and most come carpet covered/expando grilled/plastic cornered. Except for the high sensitivity, this is not your home hi fi dream speaker, more like a hi fi nightmare.

There are some pro candidates showing potential for home-based listening. Used UREI coaxial studio monitors have mid-90s sens. and do sound fine, but even the smallest used pair will go for over a grand. You may have heard of BagEnd ELF subwoofers in some of the recent audio press, they are quite good also. Most hobbyists probably have not heard of their full range designs. The Bag End TA12 is a time aligned 12" 2 way that is 100 dB sensitive,housed in a fairly small enclosure, and good to 70 Hz.

Use an SE amp on the TA12 full range, bypass the electronic xover, and use a single mono ELF woofer (models from a single 10" to 2x18"). With the least expensive ($798) ELF processor and a decent SS amp, you would be looking at a $3-4000 system. You can substitute a pair of new Gillum g3 and use a single 10" ELF woofer and the xover/integrator and get a huge flat to 20 Hz full range sound for a total of about 3K bills, plus your SE amp and some SolidState dog for woofer duty. Pun intended.

Other finds for old pro prospects are obvious. Ain't got no money? I have seen old road-worn Altec A7s with 416/511/802 with blown diaphragms for as low as $250 a pair. *(No lie—the last time I visited the author in High Point, we spotted a pair of junked A7 cabs out in the street over by the railroad tracks! That ol' boy didn't act too excited, but I'm sure he went back for a pick-up the minute I peeled out of town. - ed.)*

Bondo the corners, apply paint, new diaphragms and for $450 you can get started into big scale horn sound, not perfect but it's a start. Later add Edgarmids and biamp then you're closer to the big thang you're after. There are also lesser known bass 'bins' which may work better with Edgarmids than the A7. The JBL 4560 is a shorter front loaded bass horn. At 36" tall it has a tighter sounding bottom end and goes a smidgen lower. Road dogs of these can go for 50 to 100 bucks each.

Altec makes a short half-height front loaded horn enclosure, the 816. Same basic flare as the A7 with a tighter bottom end but slightly higher low cut off.

I heard a setup with 816s, D54 Edgarmids, Fostex slot tweeters, and all passive networks sound mighty fine, and it did not visually dominate the listening room. With most road dog rescued PA boxes, it's best to have your sound pad hidden from view, unless you're a true refinish-wiz.

All of the above has been heard either in the multi-tens-of-dollars Anodyne listening lounge or in rooms of dealers and friends of da'dyne in one form or another. By no means is this information the last word or anything of the sort, but a cryptic report on what has been seen and heard hereabouts. Important to remember is that this is all just equipment/toys and it is meant to be placed into action. Get off the phone, out of the cyberjunk wasteland, chain yourself to your work bench, then enjoy the musical fruits of your labor.

For more info on Anodyne products:

Anodyne
PO Box 6227
High Point, NC 27262
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CONFESSIONS OF A JUNKYARD DAWG!

by Steve Melkisethian, Angela Instruments

Our underground hit squad
MADE the sucker speak out!

When somebody comes to me looking to buy a single-ended amp, I usually ask what sort of music they listen to, how loud they like it, the size of their listening room, and what sort of speakers they now own. I've found that people who mainly listen to loud rock will probably not find the low powered SE experience very satisfactory no matter how efficient their speakers are. Remember, rock concert PA systems consist of super-efficient speakers (still mainly *horns*) driven by banks of very powerful solid state amps. Not surprisingly, many headbangers consider this sort of arena rock PA rig to be *ideal* for reproducing their notion of the true sound of live music in the home. Who am I to stand in the way of their pleasure?

Another group of listeners better served by higher power amplification includes lovers of large orchestral works who like their music played at "realistic" volume levels in medium to large rooms. Generally, when someone mentions the importance of large dynamic contrasts, presentation of "scale", high sound pressure levels, and a preference for digital source material, I try to steer them away from buying a seven or eight watt amplifier since no speaker known to man, whatever the efficiency specs, will deliver the wallop they crave.

Yet another group of potentially SE incompatible audionuts I frequently encounter are "the men who are married to their speakers". They want to know if these "little amps I've been reading about are any good?" I always try to explain that going SE calls for complete openmindedness in prospective speaker choices. No matter to this bunch of blindered cheap bums! The fact that they got "such a great deal" on some "*Stereophile Class B*" ranked Danish modern room dividers means that they are hitched to the damn things *for life*, or at least until their little pride n' joys are dropped from the Recommended Components List. To the dealer of SE triode amps, this means that your lovely little amplifiers will have to fit the Procrustean bed these audio cheapskates have made for 'em, or else!

My experience with SE triode amps over the past few years has brought into bold relief the realization that no one type of amplification known to man at this point is the most "absolute" in the presentation of sonic truth. All designs are flawed. They all have their strengths and faults. Which set of virtues and vices do you find most livable?

If you're willing to make some real compromises in the presentation of dynamics, low bass impact, scale, and you don't go nuts when your amp clips, then SE triodes with the right speakers will deliver a sense of presence and immediacy (you-are-thereness) that I have never heard from any other form of amplification. All good SE triode amps seem to share a unique ability to convey the emotional soul of great music through any kind of reasonable speaker. When you experience this presentation, it is unmistakable and almost scary!

Is it any surprise that the established amp manufacturers were the most aggressive opponents of SE triodes back in the '80s when most American audiophiles hadn't heard of such amplifiers? This war of disinformation was waged in the audiophile mags for some years, continuing in somewhat attenuated form even today. We were repeatedly told that none of the puny little amplifiers favored by Japanese audio 'cultists' could possible drive big, bulging American speakers to satisfying volume levels in the average American home. After all the propaganda, local audiophiles are usually shocked when they finally get to hear this stuff and find out how loud it can actually go.

Could it be that the High End establishment was scared that American audiophiles would become infatuated with a product that *they* didn't make and promote? Even more subversive is the notion that some of the best amplifiers are built at home by hobbyists, unguided by the audio experts at the mags or by "professional audio consultants" in the High End salons. Accordingly, the homebrew/DIY zone was "ghettoized" by the High-End press, considered fit turf only for bottom fishin' Dyna-scum and other lowballers.

As far as the old establishment was concerned, High End audio electronics was a *tricky* business. Only a trained engineer/artiste could achieve the proper balance of brute technical mastery and 80s sensitive guy shit required to design and manufacture such 'necessarily complex' circuits.

As I see it, the "problem" of speaker efficiency has been grossly overstated and it serves as the last line of defense for those in the High End community who wish the whole single-ended triode amplifier movement would just go away. If you have the guts to just throw the numbers out the window and listen without preconceived notions, you'll probably be shocked and delighted at the number of "illegal" (but good sounding) modern and vintage speakers that work with SE triode amps.

The only speaker kit I am aware of that was designed specifically for low power tube

amps is offered by *Hi-Fi World* mag in England. I haven't heard these but they appear to be well-designed and fairly priced (FAX 011 441 71 289 5620). I think it's likely that Audio Note UK will offer a kit version of their superb speakers within a year's time. I'm hopeful that other speaker manufacturers will see the opportunity here and jump into the fray as well.

Twenty five years ago I used to build ported, 'bass reflex' stage monitors for rock bands. I'd load my jammin' homebuilt boxes with 12"-15" Eminence ceramic magnet woofers and cheap, ringy aluminum horn tweeters on the top. At the time, these sounded better to us than anything you could buy at most music stores, so we loved 'em, especially since we couldn't afford to even dream of owning JBLs and other 'real' speakers. This efficient, primitive but venerable speaker system design lives on in dozens of commercial versions you'll find at your local 'combo' music store by Peavey, Fender, Sunn, CLS and countless others.

Recently, this design has even reappeared in the low end of the High End, targeted at single-ended bugeteers. Could this be the most popular design of all time? If you'd like to try building your own (its easy!) for under $400, call Image Communications at 1-800-552-1639 for their very informative brochure/price list of RAW speaker components (woofers, horns, drivers, replacement diaphragms, crossovers, mo'...) by Eminence, McCauley, EV and others. Hey, if you don't dig the way YOUR homebuilt babies do "hi-fi", you could always start a band!



MY fave: ProAc Response IIs

As a subscriber to the Japanese audio hobbyist mag *MJ* ($245/year HA! HA!), I have seen a lot of ads for interesting high efficiency speaker components lately, including some horns, drivers, woofers, and some alnico coaxial designs! It might be worth checking out some of this stuff if you're undaunted by the potential hassles of cross-cultural mail order! Speaking of KOOL stuff from Japan, Pioneer still offers some of the wonderful TAD pro speaker components for sale, including Alnico high-frequency drivers and 15" woofers. Wide bandwidth, high efficiency, high dollar, top quality.

My current fave speakers remain the Pro Ac Response II boxes with massive Target stands that I've used for the past four years. I agree that they put a bit of a police spotlight on the treble but the overall balance is so much more realistic and *pleasurable* than anything else I've ever heard that I don't think I could ever cut 'em loose. Yes, they are *only* 86 dB efficient. So What? Seriously, I'd love to hear a version of this design with efficiency in the low 90s, Alnico magnets, and maybe some silver wire in there somewhere. I wrote the designer, Stuart Tyler, a couple of times about coming up with a more efficient speaker design for small tube amps but NO REPLY has been forthcoming. US Representative for ProAc— Modern Audio (410) 486-5975 / FAX (410) 560-6901



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Following are some speakers I found to sound good with low powered tube amps. Check them out for yourselves! By the way, I don't sell any of these except on occasion a few of the vintage units mentioned. You'll have to take your chances in *Audiomart*, your local hi-fi shop, wherever.

1. Almost any Spendor model except the LS3/5A (too dinky sounding and too inefficient for my taste at 82 dB). The folks, including many sound biz professionals, who buy these tend to keep them for a long, long time. The old BC-1 is a true classic and sounds wonderful with small tube amps.

2. The current line up of Audio Note speakers are unique in that they are the only High End designs I know of that were developed specifically to work with SE triode amps. Sure, I'm prejudiced, but anyone shopping for speakers in this price range owes it to themselves to check these out. I plan to buy a pair of the large Model 3s for my home system later this year.

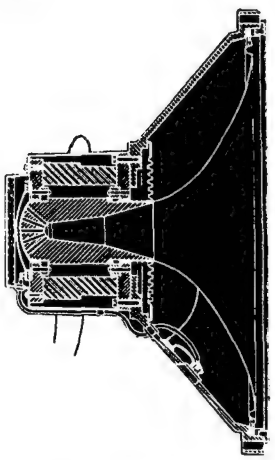
3. I heard the Royal Masturbators or whatever the @#!$ they are called in the Jadis room at CES/Vegas. [*That's Royal Master Control Reference 3A, boss. Sheesh, I can tell you ain't French —ed.*] What a beautiful sound! They were driving them with the Jadis Defy when I stopped by but I bet these speakers would sound fine with any good SE triode amp. Fanfare Int'l (212) 734-1041.

4. On several occasions, I got to hear Classic Audio Reproductions Hartsfield repro speakers driven by Atmasphere OTL electronics and I liked them very much. I have never been a big fan of the old JBL "singing furniture" approach (Paragon? Ugh! Metragon? Forget it!) but this version by JBL nuts John Wolff and Mark Weiss seems to keep the resonances down to a manageable level.

5. Over the years, I must have turned on dozens of tube amp fans on a budget to the Celestion 3 ($289/pr.) and 5 ($399) speakers. I like the earlier, non-ported versions better than the current higher efficiency models, but I still think they're a safe bet and they play much louder than the specs say they do! Like most budget speakers, these will benefit from upgraded crossover parts, cabinet panel damping, rewiring with Kimber wire, and all the usual tweakhead tricks. You'll only get the best out of these if you put 'em on MASSIVE stands (hint: make your own out of old truck crankshafts and other junkyard metal).

6. The little Acoustic Research Holographic Imaging M1 is another decent budget ($270 a pair!) choice. Once again, tweaks and stands are mandatory.

7. The Sequerra MET 7 ($750/pr.) is another popular long-term choice among lovers of all kinds of low-to-medium power vintage and contemporary tube gear. Despite drivers that look like something you'd find in the doors of a '76 AMC Gremlin, the smooth tonal balance and imaging capabilities of these speakers on good stands is most seductive.



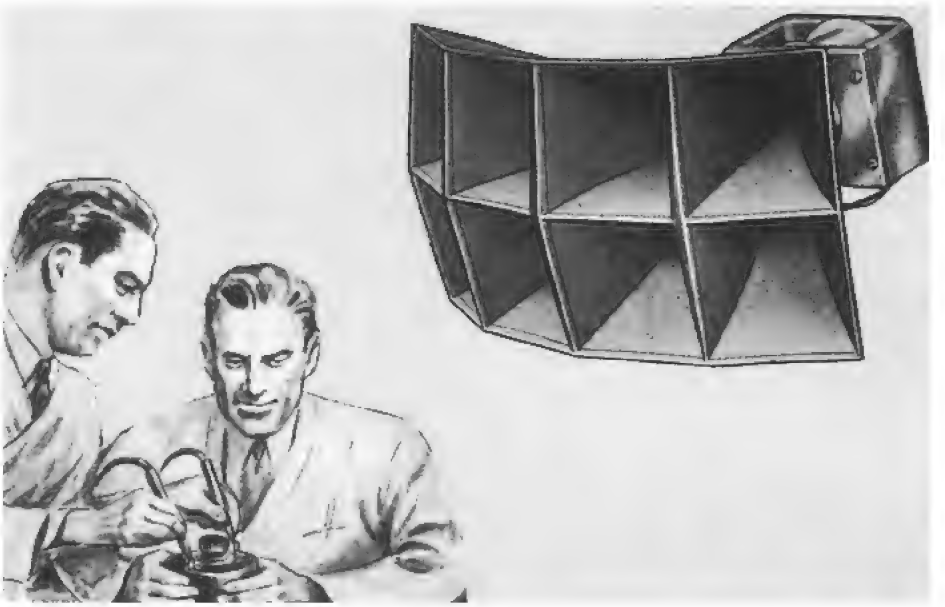
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Do yourself a favor . . . forgetabout vintage theater horns

8. Numerous customers who've bought either the Angela Model 91 amps or the Audio Note Kit One from us report good results with a bewildering array of pricey (Acoustic Energy, Sonus Faber, etc.) and Econ-O-Mojo modern mini-monitor loudspeakers. I list here only those examples that I have checked out myself but consider my "thumbs up" to be, uh, qualified since I only heard some of these boxes 'on the fly'. Still, they're worth checking out if you're doing low powered tubes on a tight budget: Wharfedale Diamond ($300/pr.), NHT Super Zero ($280/pr.) and Model 1.1s ($380/pr.), and the Dana Audio Model 1 ($199/pr.).

Doubtless there are dozens and dozens of these little boxes to try out. The results can range from dire (any LS3/5A) to delightful. In general, stick with two way box speakers, avoid the exotics (anything with a ribbon, electrostatics, and other Science Fair projects). Also, avoid anything with a LOW specified impedance and high parts count/ complex crossovers.

I suggest that you tote your tube amps down to your local hi-fi discount barn on a SLOW day and ask 'em if you can check out some speakers. Most of the folks I know who've tried this number were pretty damn shocked. There are some real sleepers out there and a whole bunch of doggies, depending on your personal tastes. It's my contention that, given the sheer volume of product out there, any determined person in any area of this great land can turn up listenable/affordable speakers if they try enough stuff. Happy hunting! Let me know what you dig up.

9. Tannoy still offers a number of very efficient (95-99 dB) 12" and 15" *Alnico* dual concentric driver designs for both the home and recording studio in several formats. Included in the line up is an OUTRAGEOUS 99 dB efficient, $30 K horn-loaded behemoth called "The Westminster" targeted at the Japanese market. Tannoy aficionados swear that the earlier models sound better. I agree but the quality of even their new stuff would put most other speaker brands to shame.

Do avoid the smaller Tannoy enclosures made from particle board; they sound *TERRIBLE!* Remount the excellent drivers in custom-made robustly constructed solid hardwood boxes, well-braced and damped. Write to Tannoy in England for plans. The US distributor is actually located in Ontario, Canada—TGI North America (519) 745-1158 / 745-2364 fax.

POSTSCRIPT: On the Sunday I was finishing this article, I took a break and hit a local flea market. I found a clean, original pair of '50s 12" Tannoy "reds" for $70! Who says that efficient vintage speakers are hard to find and expensive? Not me!

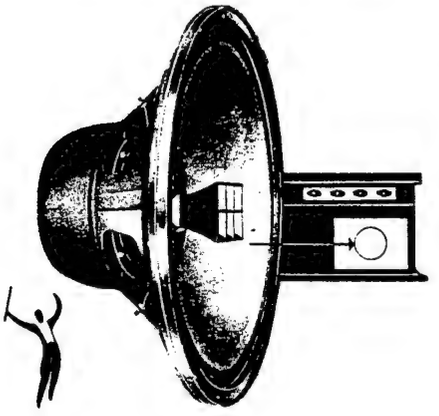
10. Technical Audio Devices offers a range of super high quality studio monitors reminiscent of older JBL Alnico designs. TAD systems employ heavy, SOLID WOOD high frequency horns and they are built to a level

of quality that is rarely achieved in today's so-called "High End" loudspeakers. Over the years, quite a few were shifted in the pro recording studio market. Maybe you should place a "Wanted" ad in *Mix* magazine classifieds. Be prepared to part with at least $5K-$7K to score these babies!! Call Barry Smith at the TAD division of Pioneer (310) 952-2387 for details on current offerings.

11. Unless you're filthy rich and can afford to outbid the elite collectors in Asia and Europe, do yourself a favor and forgetabout vintage horns. Cliched but true, if you have to ask the price for the best Western Electric and Altec gear, you probably can't afford it. Don't waste your time and energy lusting after an obscure object of desire you'll never even see a picture of, let alone own. It's maddening to American collectors but the fact remains that even if you have deep pockets full of money doesn't mean that you'll be able to buy this gear! The folks who're holding the best examples of these old speakers can afford to be damn choosy about who they sell to. Trust, honor, manners, sincerity in personal relations and other obsolete concepts count as much as money in this rarefied world.

"I don't get it Steve! I paid $6000 for these speakers and they *SUCK!*" Even if you can score some good ones, grooving to the exciting sound of horns may not work for you. To those raised on modern "neutral" audiophile speakers, the colorations that seem to be inherent in horns may be intolerable at first listen, perhaps overshadowing their unique virtues. As with other acquired tastes, persistence and the passage of time can change bewilderment into appreciation. Or maybe not . . .

12. Altec 604/B/C Duplex speaker with coaxially mounted horn tweeter (any original Alnico iteration) '40s-'70s. Popular U.S. 15" two-way recording industry stalwart.





KLH Model 17. . . bring your hand saw!

These don't do 'fast', nor some other things that seem to be important to mod audiophiles but they are efficient and lively sounding. These are highly considered by a number of single-ended amp enthusiasts. Junk the original ugly Altec boxes: it shouldn't be hard to build something mo' betta. 604s routinely change hands for $200-$500 each but you may be able to find 'em in the pro sound/recording market for less (try the OLDEST recording studios in your area). Sounds best with the also defunct Mastering Labs crossover: you can probably find these through *Audiomart* in the $250-$400 range.

13. Dyna A-25, common two-way ported box speaker, late '60s-'70s. A favorite among budget audiophiles in its day, these had pretty nice quality Seas drivers. One day, just for kicks, I hooked up a pair of these to an Audio Note Kit One and boy was I surprised at how loud 'n clean they went! If you want to check these out you shouldn't have much trouble finding 'em CHEAP from used hi-fi dealers. By the way, avoid the '90s 'reissue' of this model; it SUCKS.

14. Flat broke? Loser? Can't even afford a pair of used Dynaco A-25s? Boy, have I got a speaker for you! Meet the KLH Model Seventeen! These are so common in the thrift stores in my area that I've seen 'em used, *nailed together*, as semi-permanent structural elements in the book and record shelving! Although an old-fashioned acoustic suspension design with not so great efficiency specs, they seem to work OK with all of the low (7-35W) powered tube amps I tried 'em with. The El Cheapo paper cone drivers sound, not surprisingly, a bit 'cardboardy' but not bad either. Just for a goof, I used a pair of these at home for about a year with an ST70. You can certainly spend a lot more and do worse! Here's a tweak for you: remove (and discard!) the speaker grills. Then take a handsaw and cut the front edges of the boxes flush with the driver boards.

15. ***Steve's Top Four ONE-WAY speakers!*** Some of the best sound I've ever heard from small tube amps has been through what I call "ONE-WAY" vintage cone speakers. These old (40s-70s) full range speakers are an especially appealing match with low powered SE triodes and they share some of the same positive attributes: unparalleled midband realism and a powerful sense of presence and immediacy. True 'single point source' drivers offer some important inherent advantages over 'multi way' designs. Time alignment and phasing problems disappear. Also, you can forget about crossover colorations, cause there isn't one! Further, many of these speakers were designed with efficiency in mind since they're mainly from the pre-solid-state hi-fi era.

On the downside, power handling can be quite limited and bandwidth, even in the full range models, is somewhat less than what many modern hi-fi nuts would find satisfying. Still, some of you might discover that these relics from the past offer just the sort of listening experience you've been looking for. Interested in trying some of these? Try *Audiomart* ads but beware of sharks. Insist on original cones only! As with other vintage gear, it is usually better to obtain it from a fellow hobbyist than most of the dealers I know of. Experimentation with different cabinet designs (ported, acoustic suspension, T-line, etc.) might pay off big time!!!

1) Western Electric/Altec 755A 8" speaker. First brought to my attention in Bender and Werth's groundbreaking 80's article on vintage gear in *TAS #59*. Rated 70-13K, the "8 watts power handling" limit makes this one a natural for 300B amps! Very efficient and as fast as lightning!

2) Goodmans AXIOM 80 full range 9 1/2 inch speaker. Made in England, 50s-early 60s. The maker claimed 20-20K from this one, and that's not too far from what I've heard. With a power handling capacity of just 6 watts, the Axiom 80 certainly challenges our definition of SE triode amps as low powered! Seriously, if you're lucky enough to score a pair of these babies, be careful with that volume control since there



Western Electric 755A ad from 1948

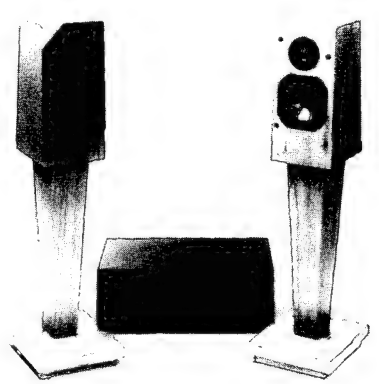
are NO replacement cones available. The other types of speakers (coaxials, triaxials, woofers, etc.) crafted by Goodmans during this period are also efficient and excellent sounding. BARGAIN HUNTERS ALERT: Goodmans sold lots of fine speakers here in the 50s-60s under the "Lafayette" brand name. (*Yeah, but watch out. Lafayette also sold a lot of early Pana-sonic imports.—ed.*)

3) Barker Duode 12" full-range speaker. 50s England. One of the strangest looking cone speakers I've ever seen! The cone appears to be made out of yellowed, parchment-like material! The sound is anything but antique, though. This one is pretty much fullrange (30-15K) and probably the fastest 12" speaker you'll ever hear! The "high flux magnet system" gives "high sensitivity and control, especially when Duode systems are used with low power amplifiers."

4) Wharfedale Super 12/CS/AL 12" full range speaker. England 50s-60s. I found one of these in a junk shop about four years ago. Picked it up because it looked a bit like the British guitar speakers (Alnico Celestion, Goodmans, etc.) I'm familiar with. Since it was Sunday, I took it home and hooked it up to my tube hi-fi rig for a quick test. When the music came on my jaw hit the floor! This was no funky guitar speaker—this thing cranked! Even with no baffle, there was decent bass! Rated at 12 Watts power handling from 30-18K, this one's a natural for single-ended tube amps! In my experience, these sound best in a REAL BIG BOX.

Other listeners report good vibes from vintage one-ways by Baker, Hartley, G.E.C., various Western Electric models and even ancient field-coil type full range cone speakers by Jensen and others. We're probably on the threshold of a revival of this type of speaker, as others will report in this issue of *SP*. Hopefully, these "new" one-ways will unite the superior materials (alnico, W.E. style complex cones, etc.) found in the best of the vintage units with the tight manufacturing tolerances and computer/laser testing methods available today. Some of these vintage or "second-wave" one-ways might turn out to provide just the sound *you* were searching for, or maybe not. In any event, this is certainly another interesting avenue for sonic exploration.

By the way, that's my point exactly! There's a big, wild, varied universe of valid listening experiences out there and no one approach is going to do for everyone.



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Loudspeaker Matching with Single Ended Amplifiers

by Graham Tricker, GT Audio

I normally consider loudspeakers to fall into two categories. These are horn and direct radiator designs. From a commercial point of view 8 watts is very limiting unless you have a market consisting of efficient loudspeaker designs like horns. I have a collection of vintage hi-fi which includes a matching pair of Voigt corner horns. In my opinion these are one of the finest sounding classic horns ever to have been made. On the whole, however, people using horns are few and far between in the UK and Europe. I guess this is due to the imposing physical dimensions needed to achieve realistic results.

Eight watts does not sound much to the average audiophile, especially when most familiar well-reviewed valve amplifiers had power outputs greater than 60 watts. Such high powered amplifiers are required to drive inefficient and power hungry loudspeakers like the panel, electrostatic and ribbon designs that have been popular these past decades.

Surprisingly, eight watts can be quite adequate with conventional loudspeakers providing the listener does not want to listen at loud levels; the chosen music is of the simple acoustic variety and not a full symphony or even worse rock music; the listening room is not too large; and lastly, the 8 watt amplifier truly measures 8 watts. Many so-called 8 watt 300B designs which run in self-bias configuration in fact only deliver 5.5 to 6.5 watts of power on the test bench.

Generally speaking, to meet all listening requirements with conventional loudspeakers, 12 to 25 watts is a minimum requirement. To achieve this output level, a single-ended design has to connect more than one valve in parallel, i.e. parallel single-ended or (my preferred option) use a single high voltage triode like the 211 or 845. In order to permit wide application, our GT Audio "TRON" range of valve amplifiers focuses on single ended Class A designs in the 12-25 watt range.

In choosing a loudspeaker to match an eight watt amplifier there are two things to consider (this also holds true for matching all loudspeakers to amplifiers):

Rule #1 is that there is no such thing as a perfect loudspeaker. Every design is a series of compromises.

Rule #2 is that one has to accept that there will be compromises and decide on a design which reduces these compromises the most for the size of loudspeaker and the type of music you will be listening to.

Horn Designs (Vintage and Current)

The principles of a horn loudspeaker (i.e. high efficiency) dictate that it is most suitable for low-powered single-ended designs. There are a number of different interpretations of horn designs, like the famous Tractrix Horn from the legendary Paul Voigt and designs like Tannoy, Lowther and Klipschorn, etc.

All of these loudspeakers have a broadly similar way of conveying a musical performance. Generally the sound is very realistic, very fast with excellent dynamics and it is often difficult to believe that a real instrument or voice rather than a recorded one is not actually in the room.

Horns were originally designed in the days of mono where a speaker had to throw as much sound as possible into a room or hall from a limited power output. This meant that they were generally placed in the corner of the room (hence the name "corner horn") and used the walls and floor as an extension of the horn.

When two horn loudspeakers are connected in stereo a big wide sound stage is achieved. However, horns are very room dependent and poor specimens can sound nasal, coloured and offer very little depth to the sound stage as well as producing large unrealistic images of voices and instruments. Some of the early Lowther and Tannoy designs can sound quite forward in the midrange often causing fatigue during listening sessions.

The best modern horn design which I have heard is the Great British Horn made by Nottingham Analogue. Based on the Klipschorn it uses very expensive drive units—see enclosed picture behind one of our TRON 300B prototypes.

Direct Radiator Designs

There exists a large variety of designs, e.g. bass reflex, sealed box, open baffle, etc. These designs generally give better bass extension, greater depth to the sound stage and better image placement but lack the dynamics and presence of horn loudspeakers.

Loudspeakers that we have found work particularly well and can be used with low powered amps are the Snell designs from America, Audio Note designs from the UK, the Cadence ES from India and the Horning and Posselt Albatross from Denmark.

The Cadence ES is an unusual design as it uses a bass reflex cabinet with an electrostatic mid range and treble unit mounted on top of the cabinet. Surprisingly this hybrid has an efficiency of 91 dB and nominal 8 ohm impedance.



Posselt Albatross



Great British Horn by Nottingham Analogue

The Posselt Albatross designed by Jens Posselt from Denmark took seven years to develop. They are a 91 dB 6 foot high floor standing design, giving excellent focus and imaging. The size is very important as it determines the correct position of voices and instruments as if the performance was being performed in front of you. We chose the Albatross as a reference for developing our forthcoming range of amplifiers. They are probably the least compromised loudspeakers we have ever heard. Posselt can be reached via fax @ +45 98 29 47 32.

Selecting an Amp for Your Speaker

Our experience when building single ended amplifiers is that the majority of audiophiles use conventional direct radiating designs and therefore the following questions have to be asked to discover whether their speaker will match an eight watt amplifier or not.

1. What is the sensitivity of the speaker?
2. What is the nominal impedance of the speaker and does it have a wild impedance curve?
3. What type of music do you listen to, e.g. chamber, symphony, folk or rock?
4. How loud do you listen to music?
5. How big is your listening room?

From these questions one can establish in a few seconds whether an 8 watt single ended amplifier will be suitable.

Here is a useful chart that can aid in the decision. Tick each question next to the appropriate column (either A or B) that suits your criteria. When complete count the ticks for each column. If there are more ticks in column A then you will need more power than 8 watts. If on the other hand you have more ticks in column B then an 8 watt amplifier may be suitable.

In determining whether a horn loudspeaker will fit the bill or whether a conventional loudspeaker is more suitable to your requirements, physical size may well be the deciding factor.

However, the question should be asked- what is the listening criteria? i.e. is it live in the room stuff or a much more relaxed sound with pinpoint imagery. If the latter criteria is more important then a reasonably efficient direct radiating design will give better results than a horn design.

My own personal preference for SE amps is the high voltage triode design like the 211 or 845 as these drive conventional loudspeakers and horns very well. Eight watts in certain domestic situations simply does not give enough power unless horns are used. Eight watts can drive a conventional loudspeaker on simple music but a full symphony orchestra on full chat will run the amp dry.

GT Audio
5 Upper Road,
Higher Denham, Bucks, UB9 5EJ UK
tel/fax 01895 833099

Question	Column A	Tick for A	Column B	Tick for B
Speaker sensitivity	< 90dB		> 90dB	
Nominal speaker impedance	< 4 Ohms		> 4 Ohms	
Type of Music	Rock music, large Orchestral		Chamber, folk, simple acoustic music	
Listening Level	normal to Loud		normal level	
Cubic room size	< 1152 cubic ft		> 1152 cubic ft	

DEGREES OF COMMITMENT

Musings on the topic of loudspeaker selection

by Don Garber, Fi

Fo, Fum. . .

If you're listening to music you want to listen to, a plastic boombox is fine. But, yes there is something better. And it does make a difference. Is there a contradiction here? I don't think so. But I don't consider myself to be an "audiophile". I suppose the major difference between myself and most audiophiles is that I hate talking about it. I can't think of anywhere I'd rather not be than a CES. With this as a preface, I'll try to respond to the editor's request for "Speaker Tips from the Amp Makers".

First who I am. I run a one-man operation, by choice. I make a number of variations on a direct-coupled single-ended 2A3 amp. I recently finished the production prototype of a single-ended 300B amp. It's now in production. I have been promising a preamp "next month" for unconscionably too long but I recently discovered a new twist that I may incorporate and which may set things back a bit. I also do custom work to order. I love designing and building things and I try to make them as simply and as elegantly as I can. I also try to get orders out as quickly as possible, sooner than promised if I can. This doesn't leave much time for speakers.

I have little experience as a speaker designer. Most of it has been pure experimentation so I'm not sure how helpful I can be. There are a lot of books and references available, but nothing beats the empirical approach.

Tip #1— If you are seized with the desire to strap a pair of 15" drivers directly on to your ears, do it. If an attempt isn't any good, you will usually know it immediately. The books are more often than not right, but nothing beats direct knowledge.

I have four different speaker systems in my home and shop. The living room system consists of Focal T120T102T, 7V313, and 10C01 mounted on a very heavy 16" X 38" board with a very minimal crossover. Completely open on the back. If I ever get the time to build in a finished form, it will be very elegant but for now it is a little less than that in appearance. Artist's rendition below.

This creation evolved from a pipe-loaded 7" Focal one-way system J.C. Morrison built for the Fi retail shop. It's 95 dB efficient and very good with a 2A3 amp (plays 95% of what I listen to), but with 3 watts it won't play everything. With the new 300B amp it's making me revise my statements about the 2A3 being the better tube. It's very live and very good. It will go a little deeper with a pipe, but at a great cost in immediacy. *Tip #2 — There's always a tradeoff.*

The second system, the Pipedream, is a case in point. With a good single driver system one can get clarity and imaging unachievable by anything else. I don't intend to slight this system but enough has been said about it elsewhere.

The third system is a modified Altec A5: 805 horns, 288C compression drivers, 515 woofers in 828 cabinets with an occasionally-added tweeter. The crossover is my own; it's much simpler than the Altec, but then I'm not using it in a movie theater either. Everything the audiophiles say about this setup is true. On the other hand, it has more immediacy, more startling reality than anything else I've ever heard. I want that. It's also HUGE and it doesn't go down very low. *Tip #3 — If you want the ultimate, you'll have to pay for it in space, money, real estate, and no doubt, other terms.*

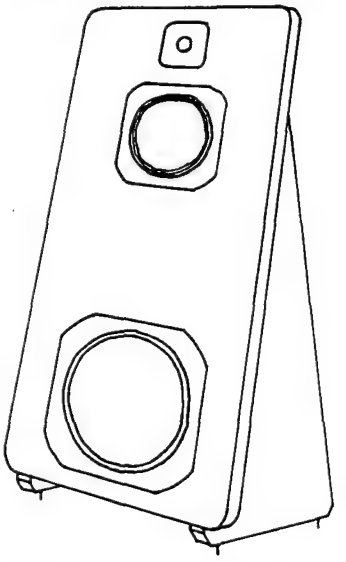
I have in mind a Japanese gentleman who lives somewhere in the mountains. Photographs published a few years back in *MJ* show two equally-sized houses on a mountainside. The one on the left has two projections out the back going uphill to a pair of sheds. He and his family live in the other one. The two projections are low frequency horns (the sheds contain the drivers) leading to the end wall where they open into eight foot a side horn mouths inside the room. He is pictured smiling in front of them. Yes, there are varying degrees of commitment.

The last system, if you can call it that, is a pair of little KLH speakers (Model 24) that I picked up off the sidewalk on 37th Street. These are high on a shelf in my studio/shop, driven by a pair of slightly minimalized Heath W3s through 50 ft. of thin Canal Street "speaker wire". It plays far better than many highendmegabuck systems that I've heard. *Tip #4— Define it yourself.*

I wouldn't feel terribly limited if I were confined to any one of these systems. They all play a lot of music well. But then, I'm not an audiophile. I don't listen to Mussorgsky or Respighi. When I do sit down to listen to music, its more often than not string quartets or Northern Indian classical music, Jazz, or a few other arcane things I wont bother to mention. You can extrapolate from here to what qualities are important in my system. But then, I occasionally listen to Mahler. There is only one way to play Mahler.

The perfect system designer is probably a Talmudic scholar: ". . . but then, on the other hand". If I should ever have the time to do some serious work on speakers, it'll no doubt start with horn loading. That presence and immediacy is like nothing else. The efficiency in itself, though welcome, is secondary. And who knows, maybe coffin bass—remember that. Komuro's new 845s are amazing on the bottom and the new preamp doesn't have multiple outputs for nothing.

Oh yes, I forgot to mention that there's a plastic boombox in the darkroom. But then, I'm not an audiophile.



Experimental three-way Focal system mounted on open baffle

Mary Anne, Mary Anne

Fascinating sound from Japan!

by Frank Reps

One truly rewarding aspect of being a contributor to a "reader driven" audiophile publication is my freedom to report as accurately as possible (my personal biases being present of course). In other words, when reviewing I don't have to be a whore! In fact, I shelled out thousands in cash before the fact for the privilege of listening to the equipment discussed below. That sure doesn't happen every day in hi-fi journalism—you can bet that the reviewers in the commercial mags are more moochers than Midases!

It seems that quite a few writers in commercial magazines bow to the advertising department and rhapsodize about products that are a complete joke to intelligent people or just plain junk. Sometimes, the size and frequency of a manufacturer's ad in the magazine appears to influence the content of reviews to an unbelievable degree. With my purely "amateur" status in mind, let me share my impressions of the products of a small company in Tokyo called Mary Anne Inc. This specialist company manufactures a series of alpha numerically designated single ended and push pull amps as well as a preamp, all called "Euphony".

According to the *New Webster's Dictionary*, Euphony means a pleasant concordance of sound. That they are! The logo on the enameled badges on the transformers also declares "Fascinating sound". The sound is fascinating but what is even more fascinating is the build quality of these products.

I saw Mary Anne Inc.'s ad in a tube magazine and was intrigued by their KT88 single ended 6 watt amp, model 231a (DC heated filaments). I ordered one, and after adding up the price, air freight, customs broker and customs duty I realized I had paid close to the price of a McIntosh amp with a lot less power and *no* dealer trade-in value.

Upon opening the box, I saw an amp painted a most unusual plum purple. I know Audio Note of Japan paint their amps dull black and Shindo products all look as if they came from Altec Lansing with their "Altec Green" color. This amp was painted a textured semigloss light plum sauce color. I doubt if there is a "Mexican Color Mixer" in an East L.A. auto paint store who could even come close to this shade of purple!

It was heavy, over 45 pounds, and looked very solid, with potted Tamura transformers and a heavy-gauge welded steel chassis. The tube sockets are mounted on separate subchassis featuring vents to provide a cooling airflow around the power tubes.

I unscrewed the bottom plate and my first look made me think that the people in this company must be either manufacturers of military specification equipment or served apprenticeships at Mark Levinson. The build quality is better than any commercially produced amp in the USA today. If the McIntosh commemorative edition is solid, this one is a tank! Attention to detail is unbelievably refined, even the tube socket connectors are shrink wrapped after soldering. All interior components are first rate. Tango and Tamura transformers are standard equipment.

The Managing Director, Mr. Kobayashi, could not emphasize more strongly that because these are relatively simple circuits, the selection of materials and components is based on intensive and extensive listening tests. Months of instrument and hearing tests went into the selection of individual components for the basic circuit. Only when a panel of professionals are satisfied that the absolute pitch, tone and timbre of the music is being faithfully reproduced does a model become a production item.

Many people know that the KT88 is a tetrode and does have third order distortion. People who prefer the KT88 like it because it has a "bloom", a punchy powerful sound bigger than life, more real than reality! The tube is great for guitar amps for this reason.



Euphony 231-α KT-88 SE Stereo
6W + 6W / 8ohms 12Hz-65 kHz (-3dB)



Euphony 131-α 2A3 SE Stereo
3.5W + 3.5W / 8 ohms 12Hz-60 kHz (-3dB)



Mary Anne, Inc. amplifier factory

The Mac 275 is another case in point—real woolly bass response, better than life midrange and sweet highs—all due in no small part to the KT88. This tube may not exactly be considered the perfect recipe for true audiophile gear, yet the same tetrode tube plugged into a Mary Anne reproduces music that is so sweet and real (I use Lowther speakers exclusively) that one wonders how they pulled it off.

On the topic of pentode SE amps, I also recently got to hear a pair of the Shindo KT88 single-ended, six watt amps driving Shindo speakers while visiting Auditiorium 23 in Frankfurt, Germany. Shindo Labs is another Japanese company with a faithful following of serious Audiophiles worldwide. Mr. Shindo's KT-88 was certainly on the same high level of performance as the Mary Anne gear. So, although it may be a lot harder to tame a tetrode, clearly it *can* be done. The six watt output of the Mary Anne KT88 amp has (unlike their 2A3 SE) just enough power for some of the more efficient traditional speakers on the market today.

Don't come to me for specialized techical test results. I'm not an engineer, I'm a hobbyist whose kids have grown up and who can indulge himself with these toys. I have tried hard to read *Stereophile* equipment reviews and in looking at the graphs and renderings of the sound patterns I think back to when I was an eighteen year old Marine in the early 1950s running around the hills in Korea with a contour map in my hand.

Contour graphs for Hi-Fi reviews? What a bunch of crap. What the hell do contour maps have to do with music? I am convinced that just like the Criminal Justice System in Los Angeles, the current crop of commercial audio magazines have lost their way. Lots of hot air — just like the O.J. trial! Their tests are a joke, a joke sponsored by manufacturers who put peanut-sized Taiwanese transformers in giant pots (to make them seem big) and mount some crappy components with glossy face plates and neat badges on audio junk. Chevy *Vegas*, that's what they are!

The honesty in the build quality and the purity of the sound of Mary Anne products is evident immediately. I'm used to the good stuff. Audio Note Japan, Audio Note UK and Gordon Rankin designed amps are sitting around the house. I don't keep bad company with mediocre amps for more than a day. Mary Anne amps are worthy contenders indeed. These amps hold their own among the elite of single ended amplifiers.

Whether the company sells *many* components here is the question. "Euphony" components will only be purchased by those unique individuals willing to pay a rather high price for beautiful sound reproduction, that in my opinion will last as long as the "collector item" components manufactured years ago in Binghamton, N.Y. (McIntosh tube gear for you new arrivals to the audio world).

Since the KT88 amp, I've auditioned the Mary Anne 300 B, their 2A3 amp and their *PA-7000* preamp which is dead silent, colorless and possibly the best built preamp in the world! The preamp faceplate is gold-anodized aluminum, 1/2 inch thick! The chassis, built up of alloy bar stock and aluminum sheet, is divided into several shielded compartments. The whole thing is held together by "machine screws", not a sheet metal screw to be seen. It comes with both MC and MM phono inputs. The MC has a 3 ohm as well as 40 ohm input. When playing music, this preamp simply disappears, adding no constraints or colorations to the sound. I haven't heard anything better anywhere.

Any readers in the Southern California area who are sincerely interested in auditioning these products and have healthy balances in the bank can contact me and I'll be happy to share the listening experience. The 2A3 will cost approximately $4,800 here, the KT88 $5,200, the 300B monoblocks $14,000. The fantastic PA5800 is $6,700. These units are all well worth the money if you want the long lived quality inherent in these products.

It may interest you to learn that this little company was formed by several professional men who are dedicated audiophiles and home amp builders. Their friends were so enthused about their products that they went commercial in a very small way. It is a spare time business for them. Since advertising rates as well as everything else in Tokyo are unbelievably expensive, their only exposure in the Japanese home market was word of mouth.



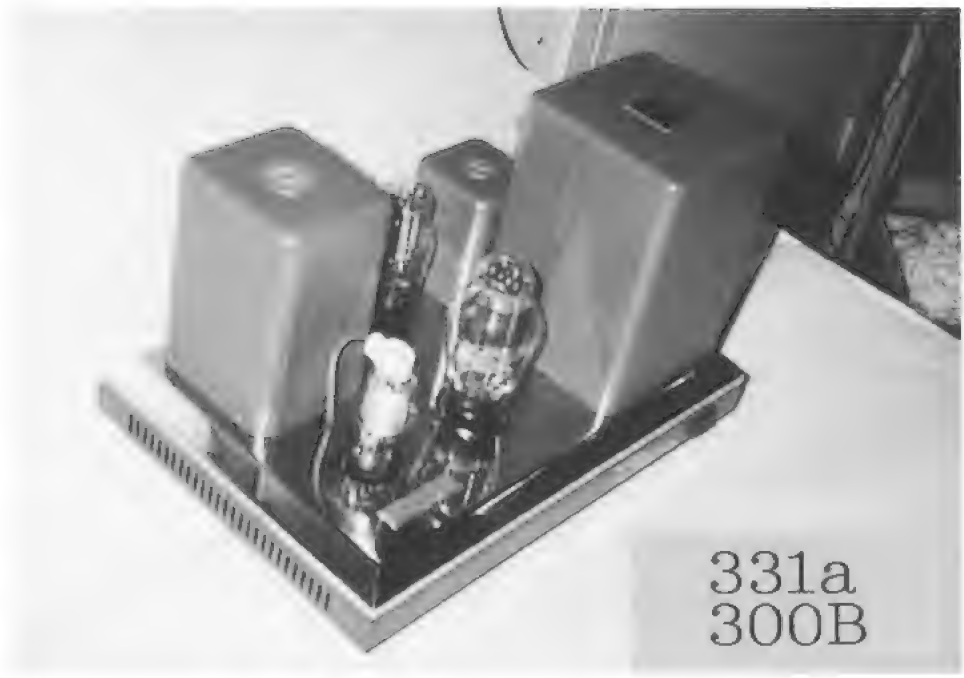
Euphony PA-7000 Preamplifier

Nevertheless, Mary Anne, Inc. has sold over 190 carefully made, hand built units in the past 18 months. Mine are not for sale! Incidentally, after using Pioneer and Fostex drivers for several years, the designers at Mary Anne are now experimenting with several of the Lowther drive units and enclosures. My prediction: Good-bye Pioneer and Fostex!

Some photos of the Euphony series are included with this article but no black and white newsprint photo will do justice to this equipment. Mary Anne products are enough to send a gearhead to heaven! I think the ideal customer for Mary Anne products would meet two qualifications.

1. He or she must be a person who loves music and really understands why good single ended amps and high efficiency speakers are the only methods of reproducing the emotion and soul of performing artists.

2. He or she also demands components that are carefree and long lasting. Components with no problems, amplifiers that can be left on the shelf to work for years and years doing their job of reproducing music in an accurate and emotionally satisfying way. In other words, Mary Anne products are pretty much perfect for the modern realization of the old golden-eared McIntosh customer.



You may pay a premium price for these fine products, but I can say with certainty that long after you have forgotten what you have paid for your Mary Anne Euphony amp and preamp you will still be enjoying your music. I think I used the proper phrase above to describe the products of Mary Anne Inc. "Modern McIntosh, for people with golden ears."

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Fax 03-3388-8260



Interior view of PA-7000 preamplifier showing compartmentalized *subchassis* construction technique for superior noise elimination



The pink and aqua cloisonné badge on the 231-α output transformer says it all. . .
Euphony: Fascinating Sound !!!!

— HORNS REVISITED —

THE EXEMPLAR PROJECT

Jeff Markwart and John Tucker
Triode Support Systems, Houston



Almost Heaven

When we finished tweaking our Altec Voice of the Theater systems as described in *Sound Practices* #4 we were happy campers. A mere triode half-watt or so into those babies produced big smiles and lots of foot tapping; movie soundtracks that sounded so right; speed, dynamics! Life was good!

Unfortunately, VOT life was not perfect. There are a few major drawbacks that come with the territory when the home music listener adopts a classic Altec auditorium design. To list a few—

Size - A pair of A7s on spikes carrying 311-90 horns on top visually dominates any normal size listening room. The decor aspect of a VOT is best described as "Early Industrial Strength" or "West Coast Monolithic".

Bass - Not much below 40-50 Hz. A subwoofer or two is needed. This sure doesn't help the size issue any.

Horn Integration - The aluminum exponential and the plywood radius short horn just don't sound the same.

After many experiments, we recognized that we stiffened, damped, and tweaked the basic VOT technology well into the region of diminishing returns. To successfully overcome the remaining drawbacks meant *major* changes, a rethinking of the basic system design to the point where the result probably wouldn't look or sound much like an A7 when finished.

We needed a smaller cabinet along with a lower system tuning point to address size and bass issues. It turned out that Altec had been building such a cabinet for many years, the Model 816. The 816 is basically an A7 horn with a much smaller internal reflex volume.

Well, we built a pair of 816 cabinets (ash veneer - still in the shop somewhere) following Altec's plans, and stuffed them with ALNICO 515Bs. Next came a matching pair of boxes to house the 811 horns, with provision for filling the interiors with sand. We filled the exterior horn concavities with patching concrete and mounted a pair of 806-A ALNICO compression drivers on the resulting 811 module.

Nice looking system; small footprint, tuned at 40 Hz, crossover at 800 Hz, 16 Ohm impedance. It sounded good in most respects but the midrange was not as articulate as the A7.

The reason turned out to be standing waves created between the parallel non-flared sides of the 816 horn. With the sides at 16.125 inches the fundamental resonance was at 419 Hz. Altec avoided this standing wave problem in the A7 bass horn with non-parallel surfaces for the short horn sides. An additional effect of the parallel sides in the



Fig 1 — Exemplar system shown with camo white A7 for comparison

816 was a higher horn cutoff due to a smaller mouth area compared to the A7, 177 Hz versus 160 Hz for the A7. These problems made a smooth transition out of horn loading more difficult.

Although our faith in the Altec drivers and horn technology was high, we slowly realized that we would have to create a system tailored to our goals to realize the full potential of horns in a home listening situation. We wanted the entire system to have a footprint smaller than an A7, offer a seamless blending of the horns, and play deep, loud, and clear on a measly triode watt or two.

Enter the Tractrix

It was during this period that we heard a full range speaker system employing tractrix horn flares for the midrange and bass drivers. The tractrix flare, although not new, has seen a resurgence of interest in the last few years thanks to the efforts of Dr. Bruce Edgar.

The tractrix expansion is unique in that it is the only horn flare whose mouth terminates at 90 degrees to its central axis. It is also the only flare that can produce a spherical waveform and it offers very low mouth impedance reflections compared to other horns. The effect of this flare is a horn that does not sound like a horn. The music is clean, clear and natural without the characteristic *horn* signature. What a difference!

We started to wonder:

- Would high efficiency, professional quality drivers excel in tractrix horns?
- Would compression drivers be suitable for use with tractrix horns?
- Would a simple two-way design be feasible and adequate?
- Would our favorite vintage drivers be suitable for retrofit?
- Could bass reflex be effectively integrated with tractrix?

We decided that working out positive solutions to these questions would bring us closer to our goal of overcoming the A7's drawbacks and improving the overall listening quality of our Altec-based horn systems.

Bass Horn Module

We started off on our design quest with bass cabinet design. In designing the bass horn we had to juggle a bewildering number of interrelated factors. The going was slow as we wrestled to produce the optimum blend of aesthetics, performance, and size using spreadsheets and CAD tools.

A few of the major factors we dealt with were:

a. Horn shape - round, square or rectangular
b. Mouth area/cutoff frequency/aspect ratio
c. Overall height to allow acceptable compression driver horn mounting height
d. Driver mounting depth to allow ease of compression driver time domain alignment
e. Optimum internal reflex volume versus aspect ratio
f. Materials and construction techniques
g. Tuning

What finally emerged from our brainstorming and number crunching activity was a freestanding, wooden, rectangular tractrix bass horn with a mouth cutoff of 135 Hz., and four 6 inch diameter rear-firing ducted ports. In order to meet our design goal of a relatively compact two-way system with extended bass response, and also utilize free standing tractrix horns to the maximum extent feasible, we decided to handle the bass below a predetermined point without horn loading. Overall dimensions of the finished product are 33" tall, 26" wide, and 25" deep and the visual aspect is far more domestic than the old A7 bass cabinet (**Figure 1**).

Since direct radiation would be important in the region where it blends with reflex energy, the bass driver would have to perform from the deep bass through the upper midrange—a span of 6 to 7 octaves. We also needed high efficiency and a reasonable reflex volume requirement.

Our initial modeling efforts concentrated on finding a woofer that met these requirements. Plot after plot of Theile-Small parameters yielded few contenders. Our favorite vintage Altecs, 416s and 515Bs were knocked out fairly early in the process due to their low mass rolloff frequencies and large reflex volume requirements.

What we needed was a driver with a huge motor, a very light and stiff cone assembly, and Fs/Qes/Vas values that allowed the best tradeoff of box tuning and mass rolloff. In a nutshell, we needed a driver designed for horn loading. Our search finally led to the current production 515-8G from Altec.

Reflex modeling for the 515-8G looked good but we were concerned about mass rolloff. Altec Applications Engineering assured us that with the light, stiff cone and large motor assembly on the 515-8G, the Fs/Qes ratio didn't tell the whole story. Altec assured us that we could expect flat magnitude response to at least 1 kHz in our application.

While we were thinking about what to do for a midrange horn, we set up a few prototype systems using the new bass module with Altec 511Bs. The unit was set up to allow flush front mounting the 511B horn with compression driver time domain alignment, and a vertical central axis height of 39 to 41 in. The 511B horns and Altec 902-8B compression drivers were installed in sand-filled boxes for mechanical damping.

We set up this prototype system for listening evaluation in four venues over several months. We tried both a stacked D'Appolito arrangement with Altec 511s (**Figure 2**) and more conventional single bass module per side with 511 compression driver horns. Listeners usually mentioned the bass modules' low distortion, high articulation, and natural transients. In smaller rooms, we got a fundamental bass response down to 20 Hz. The low end of this system got consistent praise from listeners.



Fig 2— Experimental d'Appolito configuration using bass horn prototypes with sand-damped Altec 511B HF horns

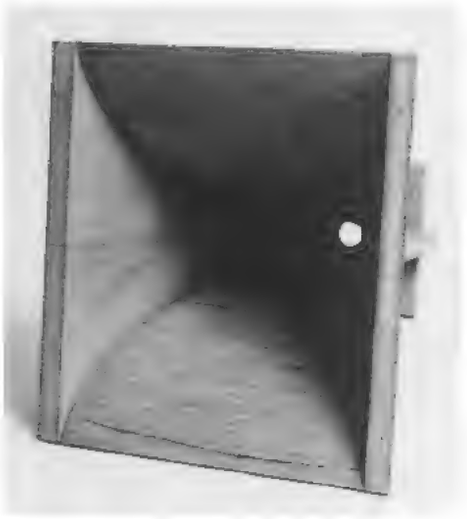


Fig 3 — Early prototype 333 Hz 35° tractrix HF horn.

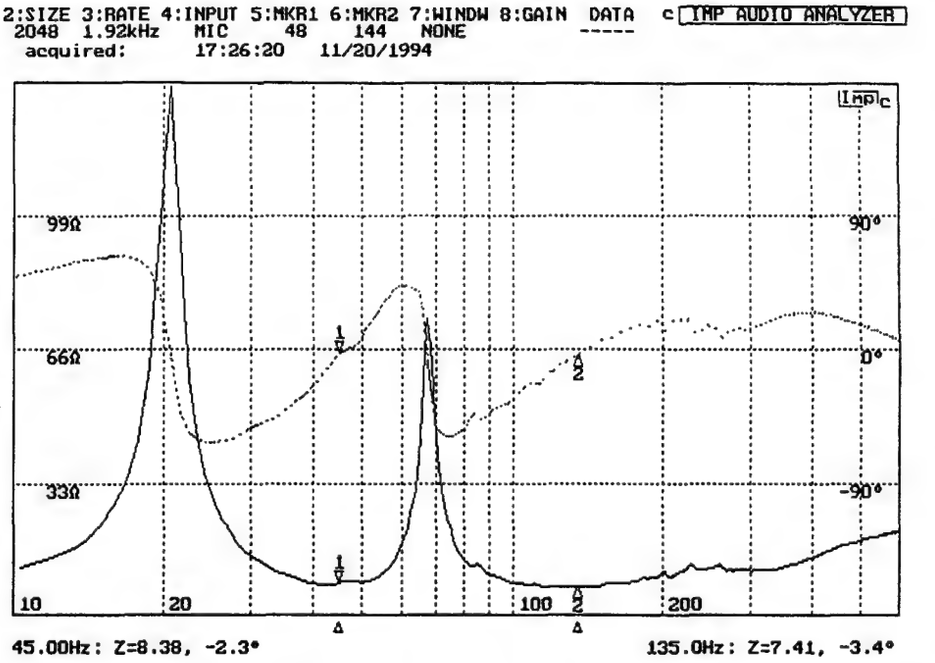
Unfortunately, comments regarding our superdamped 511B horns and 902 compression drivers were also consistent — they were way above average for 511Bs due to the sand damping but they didn't really click. Nobody could put their finger on it, but something wasn't quite right. These findings sure kept us motivated to continue our HF tractrix horn development program!

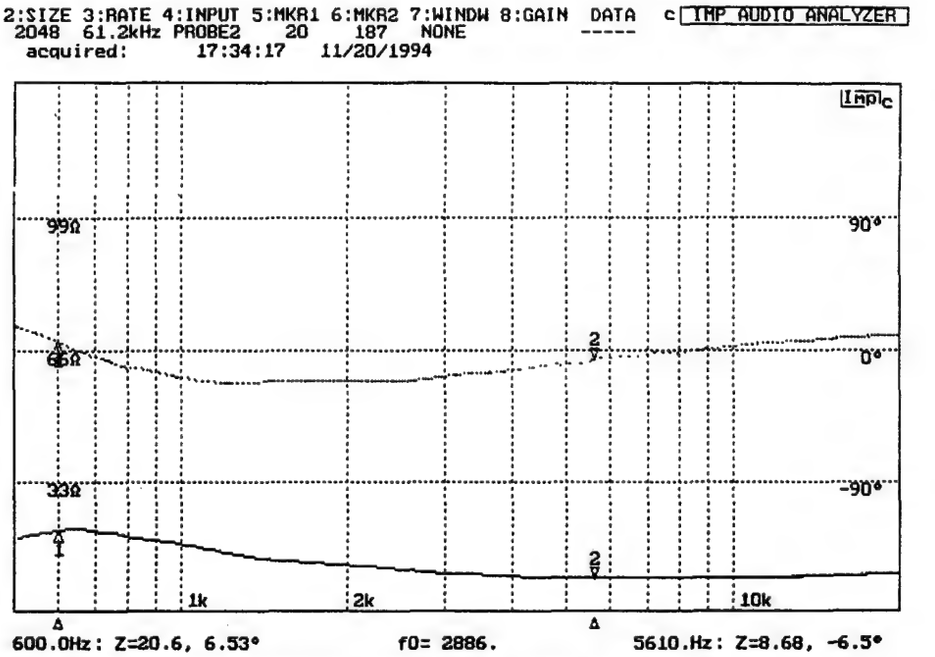
One of the big lessons we learned during this period was how different the horn profiles actually sounded from each other. And when different types were mixed, such as a VOT bass with a tractrix treble, or a tractrix bass with an exponential treble, their unique signatures were very apparent, and didn't sound well integrated. When we switched to a tractrix horn curve for compression driver loading that problem went away and the LF and HF sounded as one. The Exemplar *system* had been born.

Tractrix Compression Driver Horn

The prototype tractrix compression driver horn was also fashioned from wood, covered a narrow 35 degrees in the horizontal, and had a mouth cutoff of 333 Hz. **See Figure 3.** It was obvious from the first note that it shared the high articulation and low distortion characteristics of the bass module.

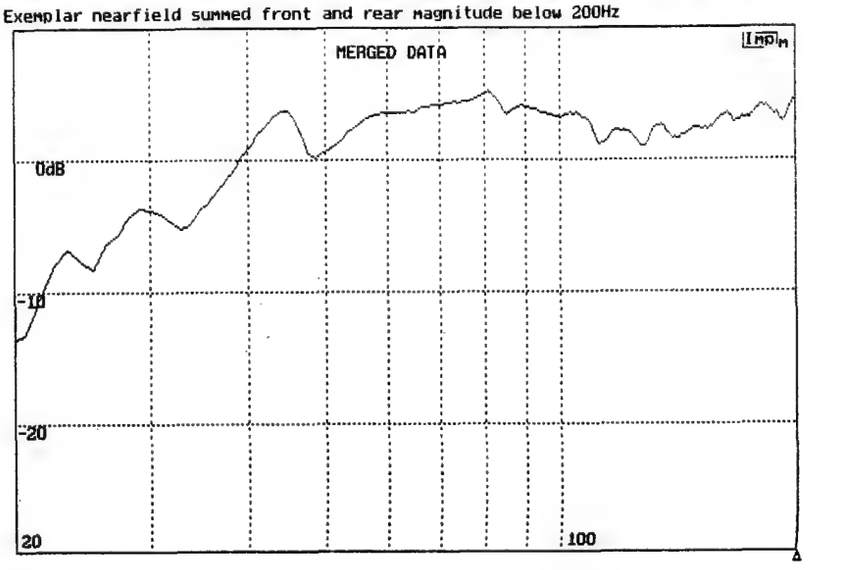
Working prototypes were then produced with a wider 70 degree horizontal dispersion, which more closely matched the bass modules in coverage angle and sensitivity. The larger mouth area produced a cutoff frequency of 232 Hz. We adopted this horn





Top to Bottom

Fig. 4
Fig. 5
Fig. 6



profile for the final design as pictured throughout this article.

An interesting thing happened about this time that at first seemed to be a disaster, but eventually proved to be significantly beneficial. We contacted Altec to order some 8 Ohm aluminum diaphragms and were told they were going to be discontinued—the aluminum alloy Pascalite would effectively replace them when all stocks were exhausted. This was distressing. I had compared the two diaphragms on 802-Ds and felt the aluminum had superior extension/transient response.

Gary Jones at Altec listened patiently but was confident that the Pascalite would be superior on the 902. The major difference between the 802 and 902, aside from the magnet material, was the phase plug. The newer Tangerine phase plug (802-8G and later) was designed for more output above 10 kHz, and the even newer Pascalite diaphragm took full advantage of it. We tested and listened to the 902-8As (effectively transforming them into 909-8As). Gary was right.

System Integration

Initial testing showed few surprises. The bass module impedance and phase curves (**Figure 4**) revealed standing wave effects in the 200-250 Hertz region created by the internal dimensions utilized. The enclosure was stiffened and additional damping material was incorporated to minimize any effects. The tuning point is at cursor 1, 45 Hz., and the minimum system impedance at cursor 2, 7.41 Ohms at 135 Hz.

Figure 5 for the compression driver shows the passive crossover at 750 Hz, a benign phase response, and a minimum impedance of 8.68 Ohms at 5610 Hz.

A composite magnitude plot of front horn/cone and rear port radiation for the bass module is shown in **Figure 6.**

The quasi-anechoic magnitude response curve for the compression driver (**Figure 7**) reveals the basic characteristics they all share; peaks centered around 2 and 4.5 kHz and falling high frequency response. Interestingly, the tractrix did better in the extreme top end than either exponential or constant directivity horns, which were typically down by 10 dB and 20dB respectively at 20 kHz.

This peaked and rolled unequalized response is what gives compression drivers their presence and speech intelligibility and it also explains why a simple shelving control will not produce adequate results in Hi-Fi applications. If you shelve down the upper midrange to match the woofer the high frequencies are lost; if you crank up the high frequencies the upper midrange drives you over the edge.

Figure 8 indicates what we accomplished with passive equalization - same test setup, same driver. An additional benefit to this equalization was that the compression driver sensitivity could be matched to the woofer



A separate sand-filled enclosure houses the Exemplar crossover

and thus eliminate the need for series padding resistance in the high-pass circuit. The resulting system sensitivity is 103 dB/SPL @ 1W/1m.

A Better Crossover

The vast majority of two and three-way speakers are designed with passive

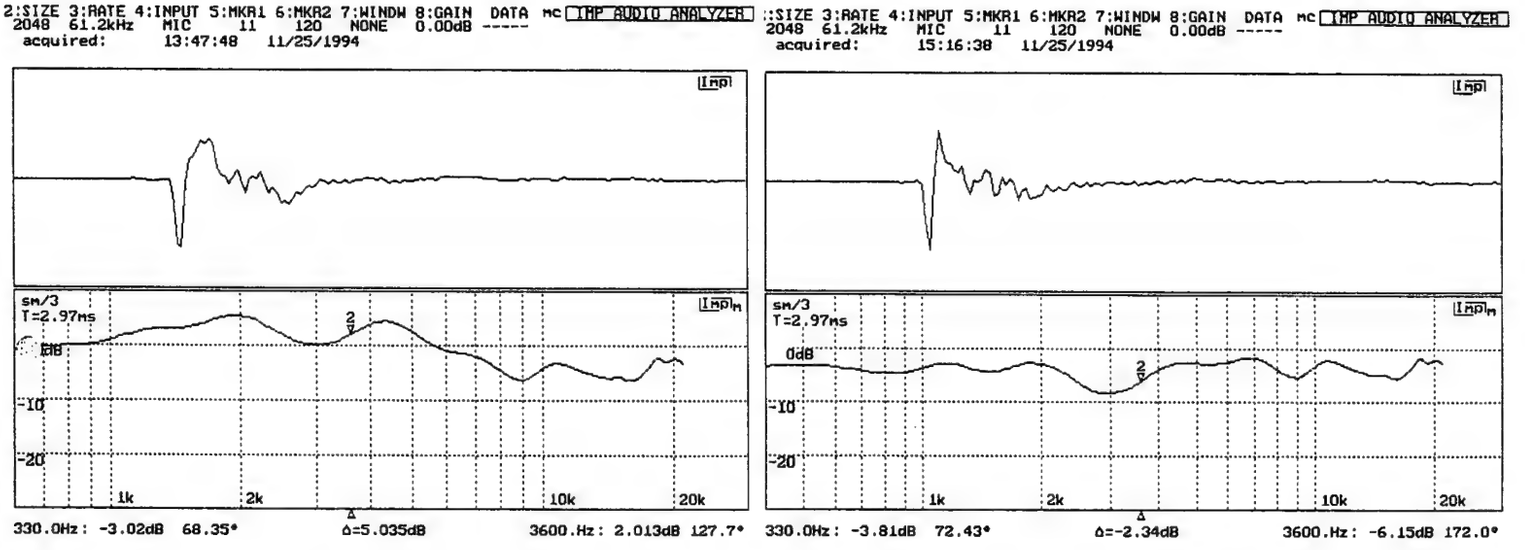


Fig. 7— Unequalized system response

Fig.8 — System response with passive EQ



Interior aspect of Exemplar cabinets showing ducted port construction

crossovers. They are relatively simple to implement for the manufacturer and hold down cost and complexity for the user. You just plug in an amplifier and play!

Unfortunately few commercial crossovers use premium parts and bi-wiring. Even fewer can be easily bypassed to allow direct access to the drivers and not many are contained in separate outboard enclosures to eliminate the acoustic and magnetic effects of a hard working woofer nearby.

The Exemplar passive crossover was designed with all of these concerns in mind. Housed in a separate, sand-filled enclosure, it is completely bi-wired from the supplied speaker cable right up to the individual drivers. Reactive signal path components were chosen for their sonic merit — Solo CFAC inductors and Sidereal capacitors.

For cable and point-to-point wiring we selected long crystal copper developed for the Japanese super-conducting magnet program. The crossover point and slope are 750Hz and 12dB per octave, the filter type is Linkwitz-Riley. Internal enclosure wiring is also super conducting magnet type, 12 AWG to the woofer and 18 AWG to the compression driver.

Drivers

Why do we use premium drivers anyway? After all, the Altecs cost many times more than the typical drivers found in most high-end speakers. Wouldn't less expensive drivers have been just as good? Frankly, *no*.

The Altecs have a lineage that traces directly back to the Western Electric theater systems introduced in the 1930s. They deliver linearity, high efficiency, and long life. We are continually impressed by old Western Electric/Altec drivers that perform flawlessly and continue to sound excellent after 30, 40, and 50+ year "break-in" periods.
The newer magnet materials used in the Exemplar drivers aren't sensitive to temperature and mechanical shock like the older Alnico Altec motors and they aren't as susceptible to overpower problems like the old Alnicos. In short, the quality plus proven performance and longevity of professional quality Altec drivers should easily offset their higher cost. They should outlast their owners!

But how well do they work? — the inevitable bottom line, and a good question. This project didn't start out as an exercise in blending engineering and art for its own sake, although there is powerful satisfaction in turning a concept into a physical reality through innovation and creativity.

Our basic goal from the start was to fashion improvements in looks as well as sound, to better satisfy aesthetic sensibilities and to enhance emotional responses to music. It needed to work on visual and sonic levels.

Looks

The matching, complimentary, horn flares terminate at 90 degrees and then continue to quickly curve away, and at the same time into each other, via the rounded cabinet edges. Flat cabinet frontal area is simply nonexistent, the horn is dedicated to producing direct sound from the drivers. The curves lead the eye inward as well along the junction of the surfaces, and give visual form to the concept of the tractrix.

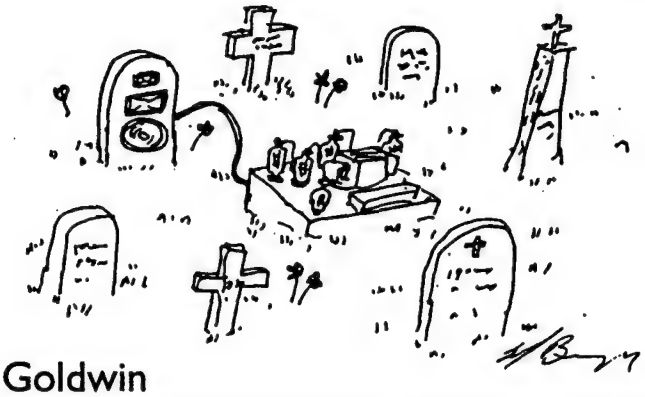
Sound

At times the speakers utterly disappear in an acoustic sense, like articles of furniture sitting mute amid sonic figures arrayed on the soundstage. They can seem totally out of place. . . we have found ourselves wondering "who parked these objects in the center of all this musical activity?"

So, after eight years of modifying, redesigning, substituting, measuring, and countless hours of listening, we finally managed to create a horn based system that does all the things we were told horns aren't supposed to be able to do. Things like deep and wide soundstaging from virtually any listening position in front of the speakers; flat, extended treble response from a compression driver, transparency; and emotional impact.

Obviously, we are very pleased with the results of our efforts. We are also pleased to be part of the resurgence of horns and triodes for home listening. By the way, some of the motivational credit has to go to the "theys" who said it couldn't be done!

WHY THIS REVIEWER IS DESTINED FOR MASS SUICIDE



by Seth Goldwin

Ain't no free lunch, pal . . .

Since building my single ended kit amps last summer I've been on a more or less full time search for a pair of speakers for them. I've heard a decent variety of low to medium cost speakers that sound good with 30 plus watt amps, but when you get into the sub 10 watt arena you *really* need an efficient design and, so far, most the speakers I've heard that claim to work with watt-wimp amps just didn't cut it when I installed them in my living room and gave a serious cranked up listen.

This time out I wanted to get serious and find something, *anything*, that really rocked my world. Furthermore, I wanted to compare whatever I found to a real fine, fine, super fine solid state amp/acoustic suspension setup. I guess the idea was to compare the fringe world of single ended amps to the mainstream cult of solid state amps, and settle for myself whether one kicked the ass of the other or what.

To do this I rigged my homebrew buffered passive preamp to have two switch controlled amp outputs. With minimal effort (two switch flicks and a volume adjustment) I'd be able to A/B the two major thrusts in audiophilia today and give you, the curious public, my report.

Well, do this I did. Despite every piece of evidence that he was committing review suicide by letting me have a pair—since the magazine I write for *loves* SE amps driving efficient speakers, and "hates" solid state amps driving acoustic suspension speakers—Ken Kantor, master of NHT and all he surveys, demonstrated the ample faith he has in his ability to design a world-class speaker and sent a pair of his flagship speakers, the 3.3s.

I powered these with the solid state Acurus 3X200 amp I usually use in my home theater rig. The other camp was represented by my hand (and home) built Audio Note Kit One 300B single ended amp and sometimes my fairly well-tweaked AES kit amp, now modified to use 2A3 tubes to pump out a bullet-stopping 3.5 watts.

The sources were a Pioneer PD-65 CD player used as a CD transport, an unimproved Theta Basic D/A converter (the official current version of this product is III, but I'm still digging the I) and a really cool, very cheap, Sumiko Project One turntable and a terrific $800 phono stage from Golden Aero Tubes. Almost all the wire is Kimber Kable, PBJ interconnect between everything and 8TC from the Acurus to the NHTs. Speaker wire from the Audio Note amp is. . . Audio Note. Just to be different.

NHT 3.3 These speakers have been near ecstatically reviewed by a lot of people who ordinarily would rather be accused of sleeping with goats than of agreeing with each other: Corey Greenberg, Peter Aczel, Mike Fremer, D.B. Keele and some guy from *$ensible Sound* to name a few. Well, I'm here to tell you they're all wrong, maaaaaan! No, actually, just kidding. These speakers are so good and provide such a pleasing and easy access to just about the highest level of reproduction of recorded music that I would have no problem recommending their purchase to *anyone* who could afford them.

The 3.3s are unusual in design. They stand 41" tall, are 31" deep (!), but only 7" wide. The fronts of the speakers are angled and contain three drivers, each in its own enclosure within the larger cabinet. A butyl foam strip runs along the outside edge of the tweeter and midrange drivers, to catch image smearing first reflections before they happen. The fourth driver, a big 12" woofer, is on the inside edge of each cabinet near the back. The whole thing is veneered in a durable, cool-looking black. There's some disagreement I guess about the looks of these speakers but I like 'em a lot and so has everyone who's come over since I got them.

Since the whole arrangement is so tall and thin, and therefore unstable, two metal stabilizer bars are screwed to the bottom of each cabinet to extend the surface touching the floor by another 3" on each side so the massive 123 pound *each* cabinets don't fall over and crush your cats while you're sleeping.

Every single unusual aspect in the physical design of these speaker is extremely deliberate, based on science, and part of a very explicit set of design goals. These goals being: extremely flat, full range frequency response in *your* room, very high volume capability and correct stereo performance. The idea of the speakers is to *exactly* follow the manufacturer's instructions for room placement and, except in rare cases, hear exactly what the speaker's designer intended you to hear.

The instructions are to put them as close to the rear wall as possible, preferably about 3" away, then to align them to be exactly parallel with both each other and the side walls. Sit at roughly the same distance from the speakers as they are from each other (i.e., make an equilateral triangle) and you're there, dude. I actually ended up sitting a lot farther away than that, and surprisingly, this had the effect of opening up the soundstage even more while not yielding the image focus an iota.

Placed this way, the speaker's woofers are firing into a 3 surface "corner" made up by your room's floor and back wall, and the slab of the speaker's cabinet. By enforcing this, the speaker was designed with the designer knowing what kind of acoustic environment the woofer would be firing into. Compare this with speakers designed to go *anywhere* and you can see the advantage. While the woofers are firing away into their virtual corners, the three way design on the angled front of the cabinet is pushed 31" away from

the back wall, angled in by 21 degrees, and stray reflections are scooped up by the foam strip. In other words, this part of the speaker is designed to both minimize room reflections and to put the listener in the right place for best channel separation and minimal interaural crosstalk.

As I understand the design, its purpose is to work *with* your room, to minimize the effects of the particular room on the sound of the speaker. That is, what you hear out of *your* 3.3s is likely to be what I hear out of *my* 3.3s, which is likely to be real close to what Ken hears outa *his* 3.3s.

Traditionally, you get a speaker and spend the next three months driving yourself and all around you crazy making infinitesimally small adjustments of the speaker placement until it sounds least bad to you. The 3.3s on the other hand were pretty optimally set up within a week. This may not be a positive selling point to those of us who have made a life commitment to the geekier edge of audiophilia, but it's a godsend for those who want to hear their music as it was recorded.

When I first put these speakers in a couple of months ago, I was astounded by their unparalleled bass performance and complete precision of focus. But I was less than blown away by their rendering of acoustic space. In fact, I thought I preferred the *el cheapo* SuperZeros. Why? I wondered. This actually lead me to one of the very few insights I've ever had about music reproduction.

Where I'd placed the SZs was almost exactly half the distance between the listening sofa and the back wall. I'd arrived at that placement by the time-tested method of moving the suckers around 'til they sounded "right." What that position does is provide a falsified illusion of depth and palpability, that is not necessarily the depth recorded. Only after listening to a good chunk of my CD collection over a period of several weeks did I fully come to trust what I was hearing from the 3.3s. On some discs, the soundstage was completely flat, while on others it would stretch to Cincinnati. With my SuperZeros I got a bigger picture, but much less variety.

The point is, that once I got used to it, I realized that these speakers tell you what's been recorded. Not everything always sounded pretty, but that's because not everything *is* pretty. Man, I can't tell you how *liberating* it then became to start listening to my records knowing that what was *on* the record was what I was hearing. Finally, I had speakers I could trust! The actual meaning



NHT 3.3

Perennial high-end favorite
big rig loudspeaker system

In-room response	23 Hz-26 kHz +/- 2 dB
Sensitivity	87 dB SPL@2.83V
Impedance	6 ohm nom, 4.3 ohm min.
Recommended Amp power	30-300W
Size	42" x 7" x 31" HWD
Weight	123 lbs. each

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Benecia, CA 94510
1-800-NHT-9993 voice
1-707-747-1252 fax

of reference gear became clear to me for the first time. And I'm telling you, all other speakers with the temerity to enter my listening room are gonna have a tough time.

The bass on these speakers is mind-blowingly good. I've never heard better in my room. It was precise and tight, yet fully capable of grunting like a tortured demon. This is bass so damned good you don't even notice it. Know what I mean? Usually on speakers with "great" bass, like the B&W 801s you're all sitting around being *pummeled* by waves of low frequency energy going "Hey, man, isn't this great??" while secretly hoping the apocalypse will happen *now* and the electricity will go out and you'll be free, oh, free, free at last, so help me God!

Not the 3.3s. Instead, all you hear is the bass energy that was recorded, in correct proportion and weight to the rest of the music. I threw all my bass-heavy shit at these speakers, and even went out and bought more. Art Zoyd, Melvins, Metallica, the killer new PJ Harvey: all went down like honey. Angry, scary honey, perhaps, but still sweet to my ears.

Another outstanding, but somewhat confusing, feature of the 3.3s is the laser-locked focus these guys provide. Why confusing? Because they don't image in the way I've heard some other focus-monsters do. For instance, the Wilson Watts seem to not only paint the picture of the instrument being played, they draw a black line around the picture like a child's coloring book so none of the color leaks out. While this can be a cool effect, to me it seems to be another lie, another way that audiophiles demand a little more out of reproduced music than they do out of live music, or for that matter the music that has actually been recorded.

With the 3.3s it is abundantly clear where and what is being played. However, those sensations are not then hyped up to a carnival level presentation of imaging fakery, like you'd get out of say, the Avalon Ascents.

Incidentally, forget about tubes with these. I tried powering them straight, and biamped, with my big gun (ex-big gun. I sold it.) 30 watt Lectron amp and my little gun AN amp and they both sucked. Bass went all to hell when trying to power the whole deal, and even biamped with the Acurus on the bottom, the tube amps, especially the AN, were just too weak to deliver the goods in other than a compressed, over-driven and distorted fashion.

When I first biamped with the AN I thought I loved it, but then the weekend came around and I turned the volume up a little and found out what it really sounded like. Just do like all right thinking Americans do and use a big solid state amp.

Overall, the 3.3s produced music in a wholly neutral and transparent way. After my initial concerns, it became clear that on disc after disc what I was hearing was what was recorded. If I didn't like the sound, it wasn't



Stage Accompany PS 44

Upscale home speakers from a Dutch leader in pro sound gear

Response	40 Hz-32 kHz +/- 3dB
Coverage angle	HxV 110° x 40°
Nominal Impedance	8 ohms
Sensitivity	93 dB, 2.83V@1m
SPL dB Program/Peak@ 1m	115/121
Size	22.6" x 14.6" x 14.4" HWD
Standard Finish	Anthracite coating

Stage Accompany USA
6573 Wyndwatch Dr.
Cincinnati, OH 45230
513-624-9977 voice
513-232-8709 fax

the fault of the speakers, it was the fault of the recording. This is a big deal not so much because I want some of my records to sound bad, but because it's important to me to hear my records as they actually are even if they do occasionally sound bad.

STAGE ACCOMPANY PERSONAL

After Joe Roberts went wild about how cool the Stage Accompany ribbon tweeter sounded with his Onken box bass cabinets in issue #7, the company was moved by his impassioned prose to call him up and offer the chance to listen to their packaged speaker, the Personal. Joe showed greater generosity than *I* ever would've and got them sent to *me* for inclusion in this review.

And for that, I lick the ground just before where his boot steps might fall so that no dust shall ever impede his path because *finally* I've found a great sounding speaker that can be happily powered by weensy-teensy watt-wimps. After many happy weeks auditioning these babies, they have only two real drawbacks: they cost $4,300 and they're *red*. The Personals offer a silky smooth, super detailed high end, a charming midrange, and a powerful, articulate bottom end on almost no power!

They're reasonably sized, about 23" high, 15" across and 14" deep. They are a very simple two way, front ported design mating a 12" paper cone woofer with a version of the totally excellent Stage Accompany ribbon tweeter and have a rated frequency range of 35Hz to 30 kHz.

Revealing Stage Accompany's Dutch roots in international pro audio, the Personal uses the completely consumer-alien SpeakOn connector. While the SpeakOn connector is convenient, easy to use and guarantees a solid connection at both ends, it's completely useless unless you've got SpeakOn connectors AT BOTH ENDS!! Which, of course, I don't. So I had to jerry-rig SpeakOn connectors on the speaker end and then solder regular old speaker cable (the green Audio Note stuff I had) to the naked ends. If it sounded bad you could question my setup, but since it sounded GREAT I guess the issue is moot.

The Personals are housed in a thick and heavily braced MDF cabinet, and as I said, mine were finished in an actually kind of cool, but *definitely* noticeable Ferrari red lacquer. I've been assured, however, that you can get other, more restrained, colors upon request. [*They probably send the red ones to reviewers to make sure they send them back — ed.]*

Before I got the specs on these I guesstimated sensitivity at 96dB. As it turns out, they are only 93 dB but man they sounded clear and loud even with my smallest amp. While raw efficiency obviously counts, there's clearly more to it than just that: for instance, a smooth, highish impedance curve.

The best sound I got them was with my 2A3 powered AES amp and that's what I did most of my listening with, though I also tried the AN amp and the Acurus. I was able to drive both of the li'l amps into clipping before reaching actually painful volume levels, but was able to hit and sustain more than reasonable volumes, even with the tiny 2A3 amp. With the 200 watt Acurus I was able to wake the dead and then kill them again. These suckers play *LOUD!* Again, even with the 3 watt 2A3 amp, I got really good sounding, powerful and tuneful bass. Not quite in the 3.3 league, but then again virtually nothing is.

As usual, I spent a lot of time moving them around in my room looking for the ideal spot but these just weren't that position sensitive. The first day I had them, they sat on the floor and boomed bass willy nilly. I immediately put them on 16" stands and like that, boom, the bass tamed itself. Once on stands, no matter where I put these in my room I got at least real good sound. The best setup was in the traditional hifi location about a third of the way into the room and approximately 30" from the side walls. I toed them in, feeling I got best imaging that way.

Overall, the SA Personals fared well in comparison to the 3.3s, suffering only in quality and extension of the lower bass. They also gave up a little of the extraordinary image focus of the bigger, badder 3.3s. What they offer in recompense is a smoother, more grainless treble. And volume. The Personals were completely satisfying playing off my littlest amp. I couldn't even *hear* the 3.3s when I tried to play them off 3 watts.

Given the paragraphs of spume I spew on speakers I don't really like, I got relatively little to say on these. They're just real damn good speakers and do nearly everything well. Great tonal balance, good dynamics, terrific bass and midrange, outstanding treble range, better than good imaging and soundstaging. I could be real happy owning these speakers, and would expect that satisfaction to last for a good long time.

While I had the Personals and the 3.3s set up for the wall to wall A/B comparison I had a fair number of friends come by and hear the two. Much to my surprise, the consensus of opinion as to which was better correlated almost exactly with the degree of audiomania: those with more liked the Personals, those with less liked the 3.3s. Interesting, huh?

SHOOTOUT CONCLUSION

The NHT 3.3s win. I'm buying them. Best, most pleasing, most music-like reproduction I've ever had in my apartment. While still being the most expensive thing I own, the $4,200 price tag strikes me as a bargain for the level of sound quality that they deliver.

The Stage Accompany Personals come surprisingly close, giving up the edge only in bass extension and clarity and in imaging focus, but beating the 3.3s in treble smoothness and air.

As mentioned above, the big deal for me in this review was to finally put a topnotch efficient speaker up against a really good "mainstream" speaker. I got real good, rockin' sound out of both the 3.3 and the Personal, both of which were sound statements I could be happy living with.

But, in the final analysis I decided to purchase the big NHTs because they gave me the most perfect insight into the actual recorded musical event I've heard in my living room, single ended or not.

So, I'm glad that I finally found a cool sounding efficient speaker in the Stage Accompany Personal. But, you know what? I'M STILL PISSED OFF. And I'll tell you why. After listening to really quite a few speakers these are the first ones I've found that I *really* want to own to use partnered with my single ended amps. So, that's a good thing, right? Yeah, sure, of course it is but these cost more than $4K!!! Well, so what, I hear you saying, the NHT 3.3s cost more than $4K too!

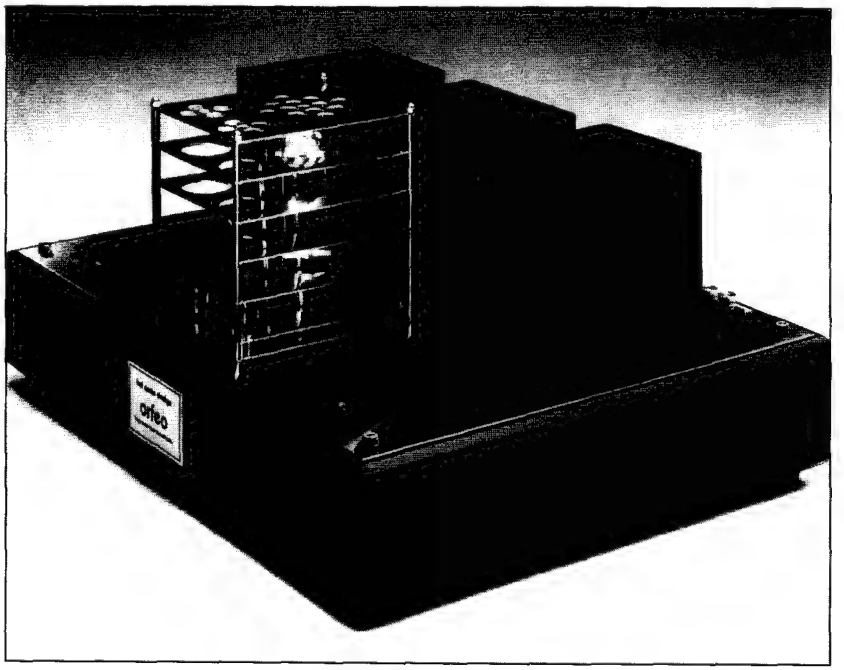
But here's my point: without really suffering *that* much I could be happy listening to my old Dynaco and a pair of $230 SuperZeros plus a $600 SW2P subwoofer. But if I *had* to slot in a sub 10 watt amp I would not be happy with *any* of the speakers I've seriously auditioned in the last year given my listening habits except for the Stage Accompany Personals.

Sure, they're a *lot* better than my lowest level of acceptability, but why isn't there *anything* in the $0 to $4,000 price range? See what I'm saying? You can get a really pretty cool sounding stereo rig together for about $3,000 but NOT if you go single ended. Then you gotta pony up and PAY THE PRICE.

In other words the single ended pursuit, like high-fi generally, is a completely fringe pursuit open only to two types: A) those with wad after wad of long green to cast into the stereo rack, and B) the simultaneously unemployed and technically talented with the time and skill to build their own.

Since we all know that food tastes better when you kil't it 'urself the single ended pursuit of perfection really belongs, morally, to those in group B, and group A should move on to sailboats which are more efficient at sucking up money.

Given that, I think the reviews I've been writing, essentially trying to bring an off-the-shelf product focus to what at this stage of market development is properly an experimenter/DIY pursuit, are bogus. Build more, buy less, have more fun. That's what I say.



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Casual Reactions:

The Search for Audio Tranquility



by Herb Reichert, Audio Note NYC

Get the tweak monkey off your back

Audiophiles who have never abused drugs or alcohol should consider themselves very lucky. Can you imagine an audio fiend on crack? He would be down the toilet to Trollsville in 48 hours. Once the audio obsession hits most music lovers are finished, never to enjoy music again. Did you ever see one of these wino-trolls walking down the street talking to himself. . . swatting flies that are not there, turning around in circles, or arranging broken bottles in perfect order? This guy is listening to voices in his head. There is a little committee up there in the control room of his skull and this crazy committee can't agree on anything. The Troll drinks and drugs to turn off these voices — or at least to turn the volume down.

From where I am sitting, it looks like most audiophiles also have voices in the head . . . "Sammy Davis says Tango is the best, but he uses 2.5K with 300B." "I thought that they used REAL *Tang* with the vodka, now you are telling me. . . Keith Richards says expensive winos must always parallel output tubes and never use oil caps." "Herb told me the Quad ESL was a wonderful speaker." "That's funny, cause he told me it was slow and incorrect." Reggie says, "Always bypass." Ricky says, "Lucy knows best about tone character." This is not funny, I get calls like this every day! An evil virus infects the mind of the restless audio consumer. People become addicted to the hi-fi 'good sound' fix. They don't realize it is not good sound but *good music* they are after. A few minutes of musical pleasure here, some tight bass there, soundstage everywhere — always trying to capture and hold on to some memory of audio bliss where it all comes together.

Winos call the first drink of the day "getting connected". Audiophiles think good connectors get them closer to the music. The guys selling audio magazines know that audio is a drug. So do the manufacturers. The minute you stop concentrating on the music and the little voice in your head says, "Maybe the bass is soft. . . maybe the string tone is wrong. . . too strident, maybe I should move my speakers," you might as well be out on the street selling your bod to get bucks for crack. You are G-O-N-E.

I know what I am talking about because I keep getting this same disease. The uncertainty, the confusion, the lack of clear *facts* all make audio difficult but it is the voices in the head, fueled by the voices in the audio press and the words of the audio salesmen that send us to Trollsville.

Crazy Facts and Twisted Lives

Reckon me this: The 1994 *Audio Directory* lists at least 2600 (!) different audiophile speakers. Five years ago, the same directory listed a *different* 2600 speakers. All but ten or so of these 1989 speakers are no longer manufactured. Worse still, how many cents on the dollar do you think you can get trying to sell one of these five year old speakers? It is important to grasp the absurdity of this dynamic.

Try calling up the manufacturer of your preamp and telling him your system sounds bad and you think his preamp is the cause. My guess is you will learn that the man who designed your amp is a wife-beater, the manufacturer of your cables is a fraud, and the store that sold you the system is misanthropic. If you think your system could sound better than it presently does, please believe me it is not your fault. The only thing you are guilty of is not telling your wife how much you spent to get it to sound this bad.

Let's just say I want to 'quit' the audio hobby and just listen to music. I decide I hate building, selling, and writing about audio. I have been doing this a long time, but let's just say I surrender—I am *burned out*. I still haven't figured out how to 'get it right', I am more confused than ever and all I want to do is stop copping audio fixes and sit peacefully listening to some piano music. What do I do? It is like kicking drugs. I may never be happy again. I can't buy a rack system or a wave radio - I am too jaded for that. I am also too jaded to think that just one more big infusion of cash will set my system up right for a long time. All I now want is simple audio peace. I want the voices of the audiophile committee in my head to stop so I can listen to everything ever recorded by Franz Liszt. If you know an easy solution, a patch for my arm or something, please call me now. If you are in this hobby and you have not burned out at least once yet, you will. The fever keeps rising.

Each of us requires a different 'medicine' to bring the fever down and some of us will need quite a large truck to haul away the audio wreckage we created while in the delirium. I spent nearly five years trying to make 4-way horn systems 'work' in my room. These were multi-amp systems with multiple power supplies and exotic tubes and parts. I fell to my knees and begged for help. This is why I stopped with the Edgar Horns —I couldn't do it. . . I broke down intellectually, physically, and emotionally. My wife said, "Don't you listen to music any more? All I ever hear is test tones." Her words were my catalyst. I *knew* she was right. Hell, I was walking down the street and laying in bed scheming system changes. If by accident you are getting like I was, here are a few suggestions and a few observations.

Too many choices

The hardest thing for most audiophiles to grasp is that the loudspeaker plays the room and the room plays the whole hi-fi. The relationship between the listener, the system and the room is the most important relationship in audio. Steve Guttenberg, Chesky's balance engineer, always reminds me: "Don't expect a Steinway grand piano to sound any better on your hi-fi than it would playing live in your room." This rule applies to a full rock or jazz drum kit or a full orchestra. You can't overload the room and expect natural timbre and clarity. All we can hope for is an intimate, naturally proportioned, realistically balanced *miniature* of the recorded performance. Therefore the size of the room, the size and radiation pattern of the speaker, the

decoration of the room and where we sit are very important considerations.

I want you to imagine your listening room with just three or four small, simple pieces of audio equipment sitting on beautiful, low, hardwood altars. Tiny pin-spots illuminate the faceplates and the rest of the room is shadowed with a Rembrandt-like glow. You have created a chamber, a retreat, a place to visit to renew yourself. I believe that if we can create the simplest most elegant system in the simplest, most serene room we can make the voices stop.

The single biggest mistake that audiophiles make is picking the wrong speaker. You can't blame the audiophile too much because there are thousands of really bad speakers to choose from. Unfortunately, once you pick a speaker that goes to war with the room, the hope of audio peace is over. If the speaker is big and ugly, the hope of simplicity and elegance is also lost. So let's start the quest for peace and beauty with small and simple.

Pick a *classic* new or used speaker that has proven its' worth through the test of time. These are easy to spot. A classic speaker is one that has been in production, largely unchanged, for more than ten years AND has retained its original value or risen in price. A one year old Avalon Accent that originally sold for $16K and is now worth only $6K is NOT a classic. A Quad 'ESL' that was in continuous production for over thirty years IS. In 1978 the ESL sold for $535. Today you can expect to pay $600 - $1200 for a nice pair. The JBL 'Paragon' and the Altec A-7 are worth ten times what they cost used in 1978! They are too big for our purposes here.

I recommend a small speaker in a small room - this minimizes the amount of obsession required to place the speakers optimally. The original Quad, the Rogers/Spendor LS3/5A, the Spendor BC-1, the Western Electric 755, the Lowthers, and for those of you who do not have a small room, I recommend my favorite speakers of all time: the Snell A2 and A3.

All of these speakers will retain their investment value, in fact they should all go up in value while you are listening to them. Will your currentspeaker do this? More importantly, all of these speakers are happy with 20 watts or less. Isn't it funny how all the classics (don't forget the Klipschorn) are speakers that work well with low powered amps? A case in point: the original Advent and the Dahlquist DQ-10 were very popular, decent sounding speakers. Tens of thousands were sold. Today you can barely give them away to an audiophile—too power hungry, not enough (any) quality high-powered amps. Can you name a 100-watt amp that has gone *up* in value?

If you are not a speaker designer, admit it to yourself. Chances are, you never will be. I sometimes like to think I am since I have been trying for 30 years—but I have never even come close to beating any of the above-listed speakers. Sorry, but what I am telling you is that the voice in your head that says, "you can do better" is lying. That is the same voice that told the designers of those 50,000 discontinued speakers, "you can do it - and cheaper too." Yeah, right!

We must stop the war between the speaker and the room. Most systems that sound bad do so because the speakers integrate poorly with the room acoustic. Play a 440 Hz tone and walk around the room. In some places you can barely hear it and in others it will be twice as loud. When I listen to most peoples' systems I become stressed because I feel the conflict between the system and the room. Quality music reproduction is simply a matter of proportion. When the basic tone and dynamic capabilities of a system are in order, in balance if you will, when reproduction has a sturdy, unshifting dynamic balance, then even poorly recorded records seem very listenable. Why? Because great musical art communicates its own proportions and when the mind can recognize these proportions during playback, the music sounds good. All we really need to enjoy our records and CDs is to preserve the basic proportions of the performance.

If you want to find peace with audio, start by TURNING THE VOLUME DOWN! You must learn to listen on a modest scale. The speakers I recommend here will minimize your placement and room coloration problems only if you learn to listen at lower than live volumes. Audio systems actually have greater resolving power at lower volume levels. Playing music quietly shows that you are sophisticated, that you have been around the audio block, and that you have recovered from audio burn out.

More than half way to green pastures

If you have a modest speaker in a modest room and your are sitting in a very nice chair listening at connoisseur levels to some PJ Harvy or some Elly Ameling, you are almost home, but the next step is VERY HARD. Almost no one gets this one: You must figure out what really matters to you most in music reproduction. Choosing one of my recommended speakers has already limited your low frequency response, some of your high frequency response, and, in the case of the Quad, your dynamic expression. In order to create a satisfying system you will have to find a CD and/or a LP source and some amplification that will not limit you any further. You must have gear that will paint with a full palette of tone color, keep extraordinary tempo, and wring the last bit of expression out of your music software.

This is tough, but it does not have to be expensive. I think many of you are already on the right track because most *Sound Practices* readers already know that a small parts count goes a long way towards creating quality electronics. More important though, is compatibility. The amp, speaker, cable combination is the motor that drives the heart. This combo pressurizes the room and gives the reproduction its sense of life. If the voice in your head says, "you must build your own audio" then build your own amp. It is possible to learn from the classic amps and build something in the basement that will not sidetrack you from your quest for audio serenity.

The *classic* amps, the ones people keep playing music with for decades, have a few things in common. First, they are usually simple tube amplifiers and secondly, more often than not, they have tube rectifiers. The most lovable preamps have tube rectifiers also. There is a beguiling sense of continuity, like a river flowing, that makes these tube rectified electronics subliminally appealing.

There is a similar effect with "split-load" inverters in push-pull amps. The popularity of single-ended amps is based on this feel ing of continuity. Single-ended is the purest expression of continuity. The best SE amps also have tube rectifiers. The full wave bridge tube rectifier is rare but the best at evoking this effect. The Mac, Marantz, WE, Fisher, Scott and Dynaco gear mostly had tube rectifiers. They also used Allen-Bradley resistors and some of the most musical of these classic amps and preamps used choke filters. A choke, a tube rectifier, and a simple design are almost a lock when it comes to classic status. Reliability does not hurt either. So what do I recommend?

Lets start with the Quad ESL. This speaker should only be used in small dedicated listening rooms. Its bass performance is near perfect in rooms of less than 5000 cubic feet and rarely 'goes to war' with the room it is

playing in. This speaker's only problems are famous: it beams very badly and it is dynamic expression is quite limited. The amp choices are simple; forget the OTLs that were the rave and stick with the Quad II. Get the amp, preamp, and tuner and enjoy your music while you watch the value of your whole system go up. The Dyna ST-70 and Citation II amps are fine also. This system will make your friends feel bad when they go home and turn on theirs. Single-ended can work here, but you must have around 18-watts with at least 20 volts swing at the output. Remember what the expensive wino said. . .

The LS3/5A will be around a long time after the Sonus Fabers are gone. These tiny boxes are the definition of what I have been talking about - let's call them an 'antidote' loudspeaker. I like the Quicksilver Monos (8417), the Dynaco ST-70, the 300B single-ended amp and the 2A3 push-pull with this speaker. Don't laugh, I honestly think the Dyna ST-70 is one of the most satisfying of all the vintage amps. Try not to modify it too much. . . leave it alone and enjoy the music. This speaker can be a fine start towards elevating your internal reference for balanced reproduction.

The Lowthers and the WE 755A are both established classics. Their character is 'fast' and chameleon-like. NOT dynamically challenged. They will play any kind of music. If you don't agree, the voices are talking wild in your head or you are not ready to surrender to audio peace. Two other possibilities; you haven't heard them with a no-feedback triode amp or you are playing them too loud and loading the room in a bad way. Speakers like these are what we climb the mountain to talk to the master about. The Holy One does not use crossovers. With no crossover you hear the cone, sorry! You also see the light.

With either of these classic full range drivers, use the BEST amp you can build or buy. The ST-70 will not do here — I recommend the Audio Note Gaku-Ons ($252,100.00). The discontinued Snell A2/A3 should still be in production. This speaker has little competition for the rank of most musically satisfying ever! Which amp? 20 - 100 watts directly-heated triode is perfect.

Next you must have a preamp, but recommending preamps is tough for me. There are only a few I can personally say will bring audio peace. Most preamps lack naturalness and ease and therefore will turn up the volume of the audio committee in your head.

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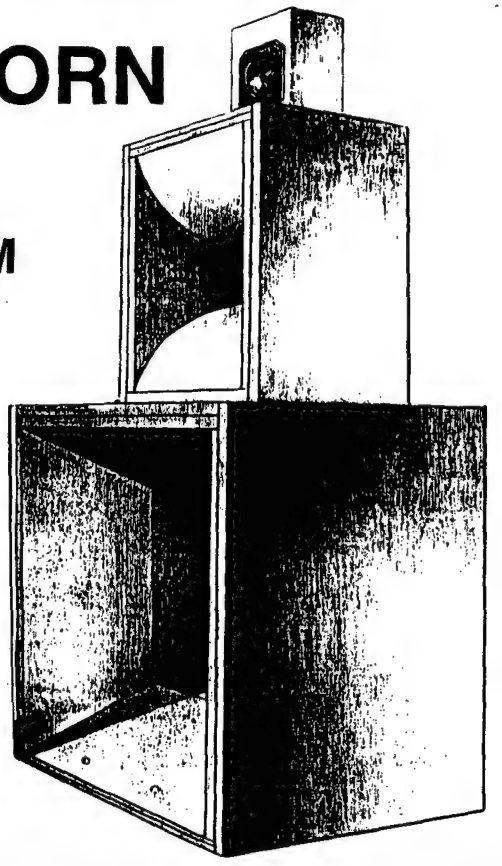


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From a home builder's standpoint I say build the RIAA and the line stage from any RCA tube manual and get a step-up transformer for your MC cartridge. The Marantz 7-C has become a high-prop collector's item that is fundamentally charming and engaging but not simple enough for audio peace. I hate to say it but I like the Dyna PAS II. This preamp is weak on information recovery but simple and honest. Again, don't modify it too much.

Remember, our goal here is to create a simple system that will impress ourselves and our friends with its ability to draw us in and make music enjoyable. Some other possible choices are the Audio Research SP-6B, the Vendetta phono stage, and maybe the Super-It. If you get this far towards audio peace maybe you can tell me which preamp works.

I am still too front-end crazy myself to make any firm recommendations regarding software playback. The Linn LP-12 and the Rega tables are a good place to start. After these, the investment aspect gets shaky. CD? You-pick-em! Trying to buy a separate transport, cable and DAC from three different manufacturers seems unmanageable and a sure-fire formula for turning up the voices.

I must say that my heart is truly with the music lover. Buying a satisfying music playback system from a high-end audio salon is nearly impossible. Audio magazine reviews only make the confusion and the fever rise. Building your own is a formula for years of lost sleep. Where does that leave us? I think the builder or the buyer can both enjoy the process of acquiring and listening to a good hi-fi if they just remember to limit their aspirations. Don't tax the room; choose a small simple speaker. Don't tax your budget; choose components that retain their resale value. Don't tax your mind; choose components that have *proven* their worth and musical prowess over time.

Most important of all—work slowly and trust your own feelings.

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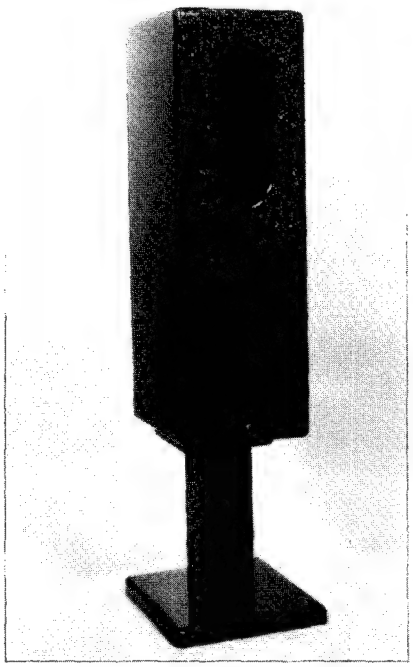
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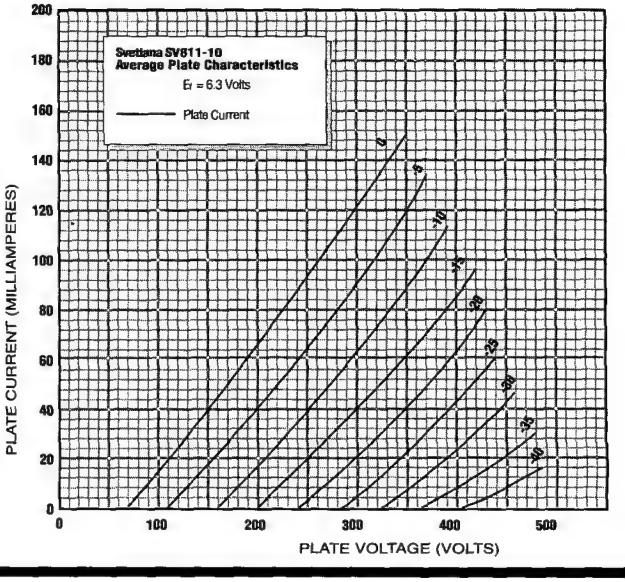
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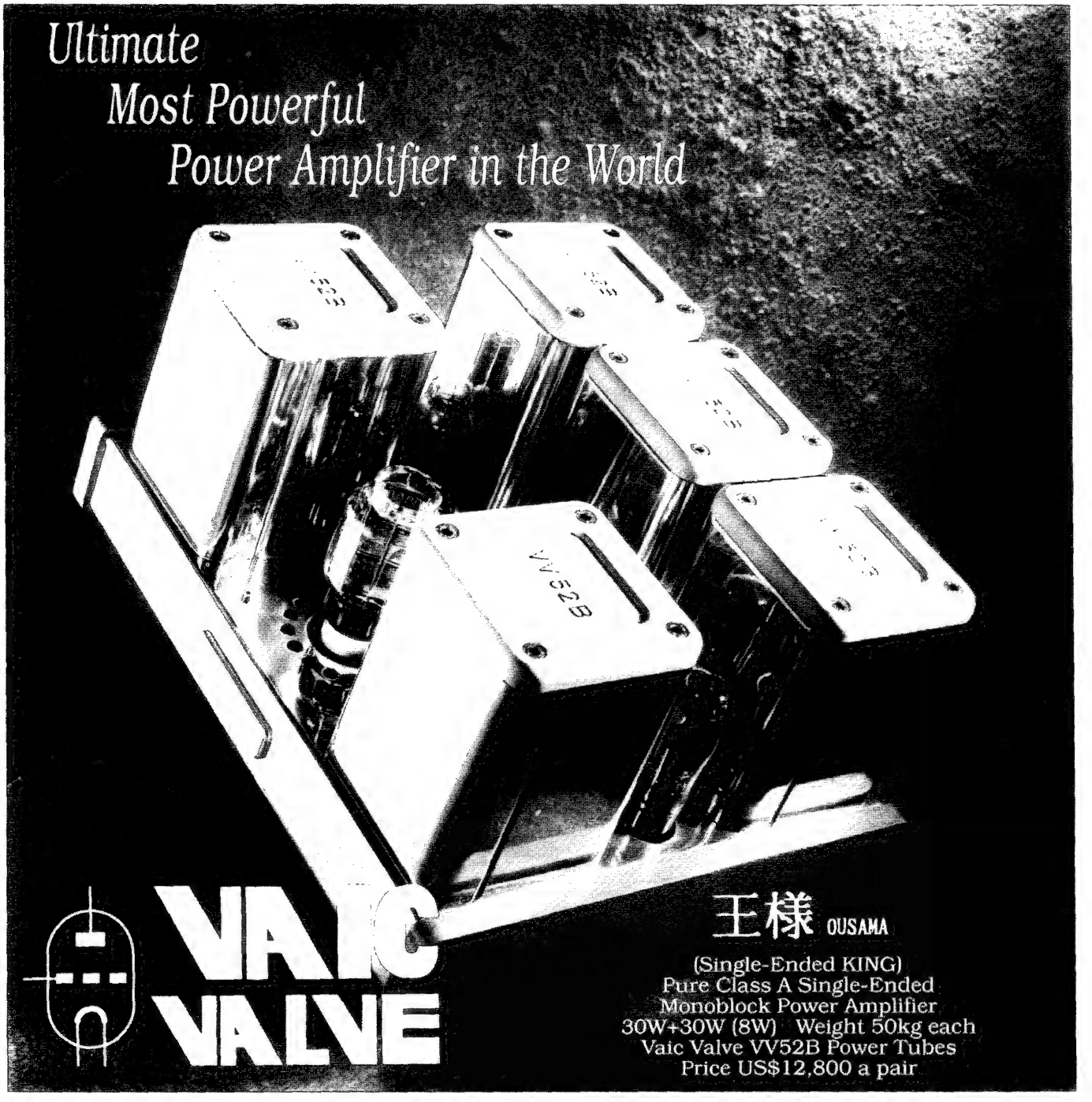
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W.A.F.

by Joyce

The Do-It-Yourself Life

About 100 years ago, when we were still counting, my future husband got himself caught in a piece of heavy equipment during the graveyard shift at work. Luckily everything was expertly patched together again, but he still faced a long recovery period wearing an arm cast so enormous it should have required a license plate.

"Isn't there *anything* I can do for you?" I was moved to ask during one visit. He hesitated, "Well, there is one thing. . ." "Anything," I murmured, kneeling at his bedside. "If you really want to, you could put in that phono amp mod in my PAS." I stood up so fast I nearly fell over in a faint. "You want me to what???"

I was trapped and good as lost. I'd just been conscripted into the murky underworld of audio electronics. I learned to solder. I learned to saw. I learned to read schematics, rewire circuits, work a drill press and punch exquisitely sharp round holes out of raw steel. I became his toy, a slave to every whim of this bandaged-up DIY monster.

"This really is kinky," I'd find myself thinking, a smoking soldering gun in my hand. After all this is *someone else's hobby* you're engaging in here. Kinda like being asked to play with someone's train set while its passionate owner sits and watches. You can tell they're trying to be a good sport about it, but the whole time you *know* they're just *dying* to rip those controls out of your hands.

When the cast came off, I solemnly (and gladly) handed over the soldering gun. He stayed up until 4:00 am touching up a few cold solder joints I'd made. Months of deprivation had left their mark. No appliance in his path has since been safe from his tinkering. (Remind me someday to tell you about the time he beefed up the espresso machine...)

Everything changes once they go DIY. Be forewarned that let loose in a home, a DIYer can have more impact on the landscape than a herd of snorting water buffalo on the rampage.

For starters, no matter how much workspace you may have in your house or garage, you might as well kiss your kitchen cabinets, your shelves, your every empty surface goodbye. Eventually, your dining room table is bound to become the setting of a major, possibly permanent, audio project—unless of course he already has another hobby going there.

It may begin as a discreet little "weekend project" sharing a modest spot with you at the far end of the table. Before you know it your "little visitor" will have outgrown the family dog and like me you will become an expert at eating dinner from a plate delicately balanced on your lap.

While there's no doubt that ongoing audio electronics projects will disrupt your life, it's those famous *future* projects I've learned to watch out for. DIYers are amazing pack rats. Some find it impossible to pass a loose piece of wire or scrap of sheet metal in the street without moving in for a pickup. To the avid DIYer, any little bit of hardware represents a potential junkie fix. On trash night they can sniff out hot project opportunities like a pipe head homes in on a crackhouse. One thing leads to another and before you know it he's got a stash in virtually every corner of the house.

So I was surprised a few weeks ago when he came home from a local ham radio swapmeet seemingly empty handed. "Don't tell me," I tried to guess, "you left whatever it is tied to the roof of the car, right?" He shook his head sadly, "Nope, I didn't see anything really good. In fact, all I got was a power cord I need for that old 386 upstairs in the linen cabinet."

I was very impressed by this uncharacteristic show of restraint. *One* power cord? And not just any power cord, but a genuinely *needed* one? I felt a sudden rush of pride as I envisioned my man standing firm in a sea of boundless electronic temptation, the single power cord clutched in his hand testifying to his tempered judgment and self-control.

"It's in the trunk", he remarked, waking me from my reverie. Which should of course have been enough to warn me that no way was this going to be your ordinary power cord. Nothing could have prepared me for the actual sight of the box that he literally dragged into the house. It was so heavy it left ripples in my wall to wall carpeting in the wake of its passage across the room, and the floorboards audibly groaned and strained when it finally came to ground near the coat closet in the hallway.

While I was awed by the sheer size of the box, it was the giant Gorgon's head of severed electrical appliance cords inside which left me staring, speechless and transfixed. From the snaking wire tendrils escaping over the sides to the impenetrable writhing knot of rubberized wire at its core, this thing was not only impossibly large and unwieldy, it was absolutely hideous.

Catching his breath after his exertions, he reached down and pulled out a single cord which had somehow, miraculously, managed to set itself free from the mass. "When I tried to buy one of these power cords, the guy told me to just take the whole box," my husband said, seeing the look of horror on my face. "These are hospital grade plugs," he added, as if that explained everything.

"What on earth are you going to. . . Hey, that's my coat closet!" I began to protest, but Medusa bounced into the closet and was already starting to look at home and familiar next to a crate of dusty WWII radio parts.

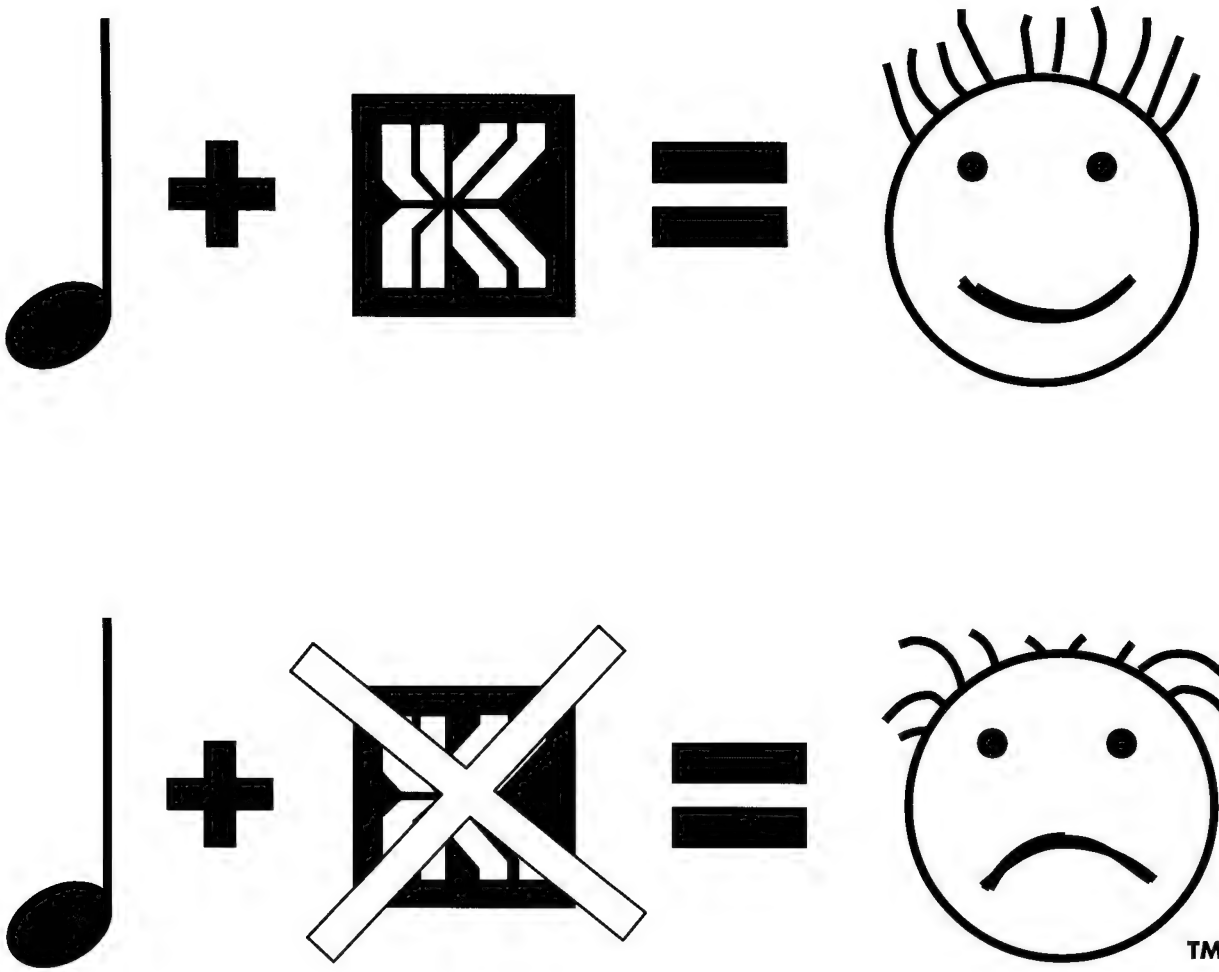
"It looks like you're running a small salvage operation in there," I told him. "It's way too warm for coats around here anyway," he countered, closing the closet door. I made a face at him, but I think I'm beginning to catch on. When they're a part of the DIY lifestyle, simple coat closets, like ordinary dining room tables, are destined for far, far greater things.



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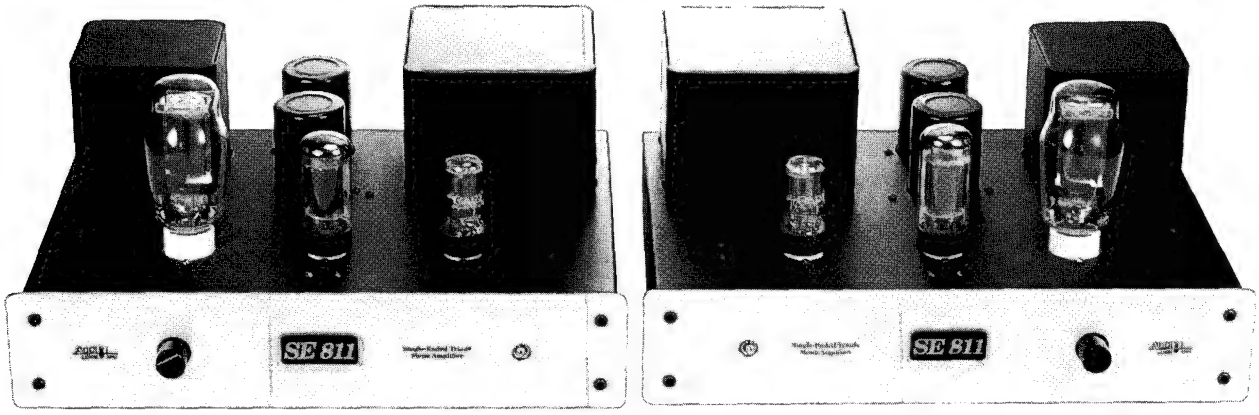
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Alternatives to Home Theater Issue 10

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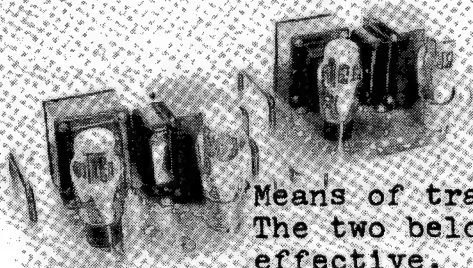
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1 to assume a mental set voluntarily. 2 to shift voluntarily from one aspect of the situation to another. 3 to keep in mind simultaneously various aspects 4 to grasp the essential of a given whole; to break up a given whole into parts and to isolate them voluntarily. 5 to generalize; to abstract common properties; to plan ahead ideationally; to assume an attitude toward the mere possible and to think or perform symbolically. 6 to detach our ego from the outer world.

一、心智活動。二、變換主題；四、體會基本內在意念；三、合併小要點；五、綜理各項事務；六、考慮自我形象；自我意念；消除一切世俗之思慮。

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. . . and MUCH MORE !!!

Mystery Cafe

They sell a lot of different kinds of gourmet coffee beans down at the local health food supermarket. Some of the beans come from organic collectives in Mexico and some of them are imported from Java, an area known for a particularly rich cup. I know all this because this isn't just a coffee stand. This place is a damn Coffee Information Center. They got a rack of free pamphlets, a few coffee aficionado magazines, and self-published books on the holy bean so you can study up on the spot and make a well-informed purchasing decision. If reduction of uncertainty is your thing, you came to the right place to buy your French Roast.

That's one way to approach it—read a few books, go out and talk to a few knowledgeable salesfolks about the best coffee for your needs, and you can probably develop a pretty good feel for what kind of coffee to get down with when you're ready to make that big investment. I'm sure you will find plenty of people to talk with about grinders and whatnot, if that's what you want to do. People into coffee love to talk coffee, and everybody has an opinion. With a little study, one could certainly get a handle on the expert consensus on which beans to like and why, for whatever it's worth.

Down at the far end of the coffee aisle, almost out of sight, there are usually three or four bulging bags of pre-ground coffee marked down to a ridiculously low price, like $1.99 a pound. The label says MYSTERY COFFEE. It's a total crap shoot. Could be primo Kona AAA ground for auto drip just like you want it or it could be the mongrel residue that the janitor scrapes out of the grinder pans at the end of the day. Good luck.

I don't know who buys this mystery coffee but I don't think they're buying it only because it's cheap. Maybe they're the type who can get some worthwhile sensations from any kind of coffee. Live with anything for a week, appreciate it for what it is, and learn from the experience. I know that some hardcores are into the special buzz only a headlong dive into the unknown can bring. Some probably wish for the scrapings from the end of the day, craving the mysteries of the cup in their fullest mystery. All are living in an expanding universe. Every sip a new step. Mystery coffee drinkers are a special breed. Experimenters.

I'm sure the people who subscribe to those fancy coffee magazines do not look upon the mystery coffee drinker with favor. Why not just get in the groove and drink the fine brew everybody else is happy with? Many well-reviewed beans are available here in town. There's even a Starbucks in the Austin airport now. Nonetheless, some choose the mystery coffee. Perhaps they recognize that truth in coffee only resides in individual experience. You can never know the taste until you drink it yourself.

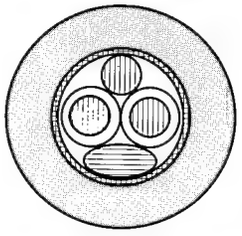
That's the problem with reading about drinking coffee. You can get caught up in the logic of the written word and follow your mind to a place where you only think you'll be happy. It's easy to get misled because you like or dislike certain metaphors or verbal images and lose sight of the unique non-linguistic character of the coffee drinking experience. Think of all the people who missed out on Raspberry Mocha because it got a few bad reviews.

There's a wide wide world of coffee out there. From syrupy Turkish to the barely-brown mop water served up in seafood chain restaurants in the American Midwest, one word can hardly contain it. Finding the right blend is a big job but it's worth taking the time to do yourself the favor. You'll know it when you find it. You can't know it before you do.

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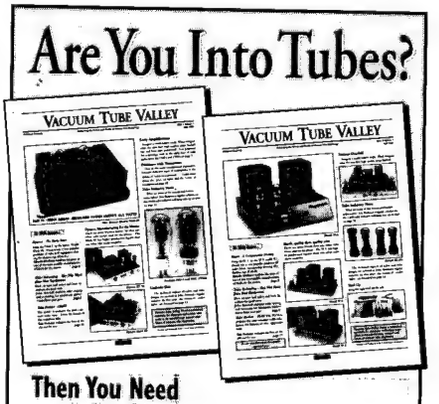
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VEGAS 1996
The CES that time forgot

by Joe Roberts

Even though I'm sure there was a lot of great transistor amplification in the house, solid state was dead as a stone at this year's CES. That new design transistor sound could have been better than ever, but it didn't matter. Most of the amp manufacturers, most of the speaker manufacturers, most of the wanderers in the hall seemed to be into tubes. I'd say 70% of the rooms used tubes and 90% of the interest was in tubes. Yes, indeed, tubes were the biggest in Vegas this year.

Not only is the venerable vacuum tube enjoying a major explosion in popularity, the general level of innovation and experimentation in tube audio is very much on the rise. We're moving way beyond the standard issue 6550 and EL-34 space heater push-pull amps that have been passing for exotica for the first two decades of "high-end" audio. Usually, CES is just a bunch of Americans, Europeans, and Asians trying to sell each other the same old retread PP ultralinear designs. This year signs of intelligent life in the tube audio community were everywhere.

We're lucky to be living in an era of rapidly expanding options in tube audio. I consider the late 90s to be nothing short of a new golden age of vacuum tube audio. There was a healthy supply of genuinely inspired and exciting tube amps at CES '96, including more fancy big triode amps than I ever thought I'd live to see.

But there are some old-style push-pull amps around and some of the oldest are among the newest. Perhaps *timeless* is the word.

I couldn't believe my eyes but MARANTZ is reissuing the Classic line of tube equipment, namely the 7C preamp, 8B stereo amplifier, and Model 9 amplifier. The aim of the project was to make the reissues as close to the early articles as possible, using parts from the original suppliers whenever possible and so on. They put real 5-way binding posts and IEC connectors on the stuff but otherwise it looks mighty authentic down to the ultra-cool bias meter on the 8B.

Of course, the Marantz Classics will be built in the USA. A new North Carolina plant just opened where Kevin Hayes of VAC will oversee production. The 7C and the 8B will go for $3800 each. The Model 9 monos are $4200 apiece. Seems on line with Asian collector market pricing for the used stuff but at least nowdays you can get a fresh unit and a manufacturer's warranty.

Isn't it interesting that Marantz, a subsidiary of Dutch Philips, would be investing a bank of Guilders in the bygone fantasy that Marantz represented back when it was a small specialist company out on Long Island making top-notch gear for 1950s purist hi-fi buffs. Some dreams are eternal, I suppose. Universal, perhaps.

Yo, what about the Model 1 Audio Consolette mono preamps, my favorite Marantz item? What about the fabled Marantz Electronic Crossover? Huh? The legendary Marantz 10B tuner??? These days, anything is possible. I wouldn't be surprised if they start making false teeth out of wood again.

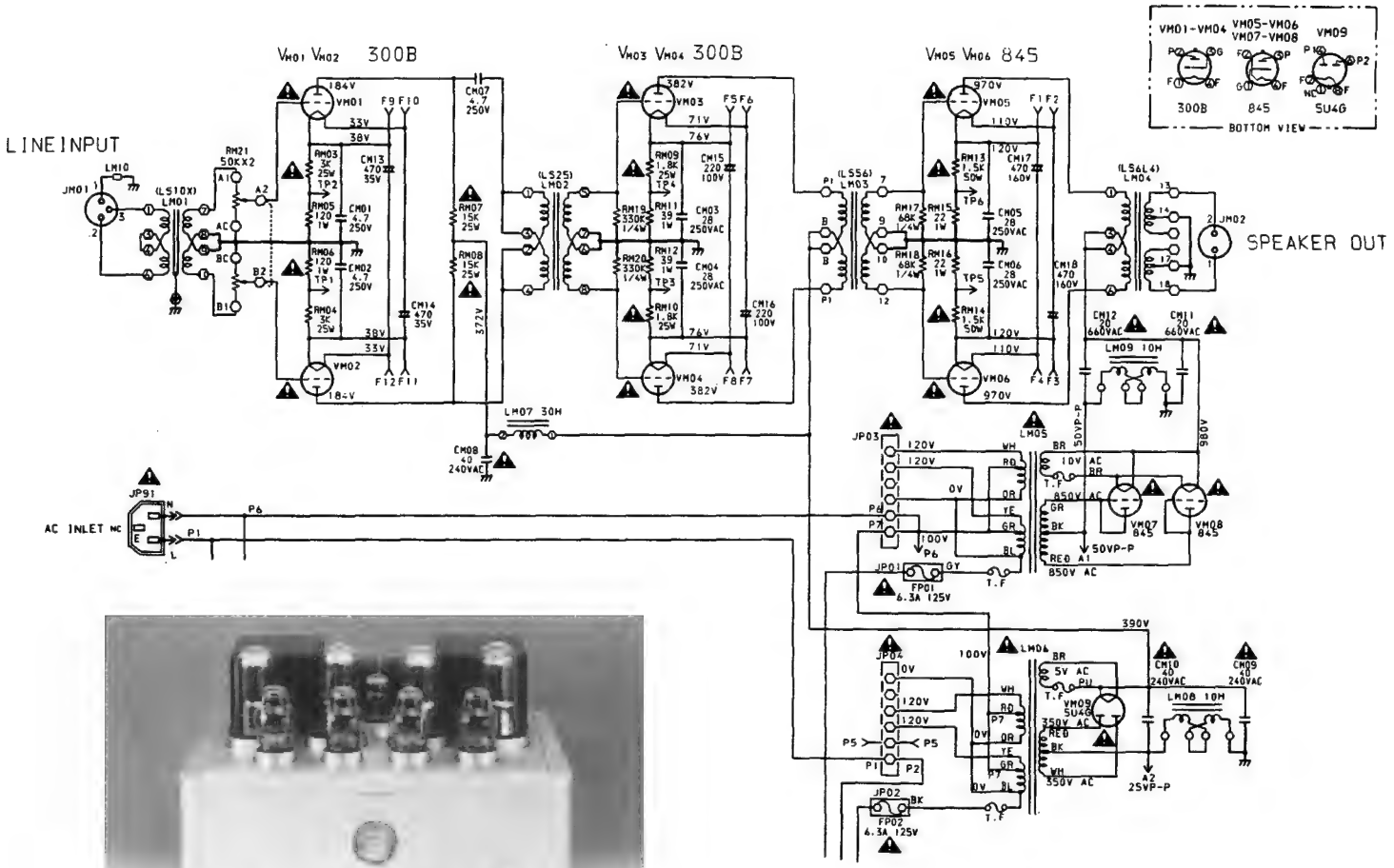
If the 7C/8B/9 classics are too retro for you, Marantz is showcasing a major statement piece in the form of an enormous $50K per pair 845 triode push-pull monoblock power amplifiers called the Project T-1.

The T-1 is another significant marker of the timeless and international character of the emerging tube super-fi scene, and all-out design of the engineers at Marantz Japan. The T-1 reflects a vision of audiomaniac splendor germinated within the upper strata of the Japanese experimenter community where the quest for good sound is not constrained by narrow concepts of "up-to-date" design practice. In a combination blast from the past and whiff of the future, the Project T-1 incorporates an input transformer and two interstage transformers per side! The audio transformers are all classic American UTC designs remanufactured to Marantz order (note LS numbers on schematic).

Seriously, an amp like the T-1 makes you wonder where old ends and new begins. It's like an ancient thing that never happened before. The Project T-1 uses a pair of 300Bs to drive another pair of 300Bs which drive a pair of 845. Never saw that tube lineup before. A second pair of diode-wired 845s serve as rectifiers for the output 845s in the manner of the prewar Western Electric Model 43 theater amplifier where you could recycle the old 211 output tubes in the rectifier socket. Truly a directly-heated triode lover's dream!

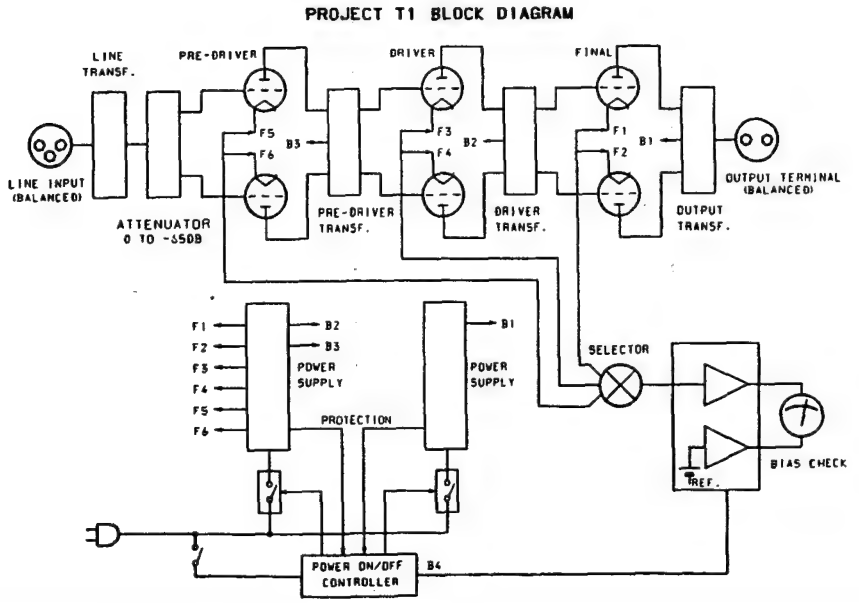


Classic Marantz fans inspecting the goods



marantz

T-1
Monaural Amplifier



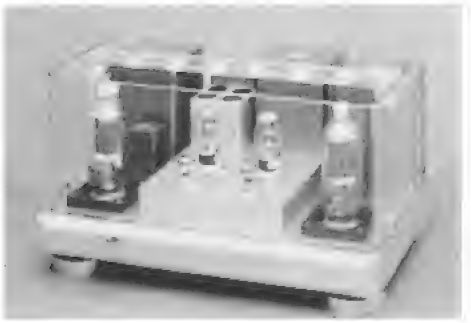
The Project T-1 resonates with old-time feeling but it is as modern as the World Wide Web. Microprocessor controlled turn-on circuitry and solid state current-regulated heater supplies run those good old fashioned triodes. This amp definitely ain't no antique.

Some of the top audio gurus in Japan swear by interstage transformer-coupled amplifiers and all I can say is let's hear it, even at $25K and 120 pounds per side!

If you're intrigued with the concept of interstage transformers but you like your triodes served up single-ended, the man you need to see is Nobu Shishido, designer of the luxury class WAVAC SE-DHT amplifiers crafted by YOSHIKI INDUSTRIAL CO., LTD.

Shishido, a legendary figure in the Japanese DIY scene and senior contributor to *MJ* and other Japanese experimenter magazines, was one of the first public advocates of SE directly heated triode amplifiers back in the 70s. He discovered interstage transformers a few years later, so before anybody was listening to him about SE-DHT he had already taken the next step into the beyond.

Nobu-san argues that interstage transformers provide an enhanced experience of the subtle information at the threshold of hearing, making SE amps even better instruments of low level resolution. Although Nobu-san insists on SE DHT, he argues that PP amps can also benefit dramatically from transformer coupling.



The unbelievable WAVAC 805 from Yoshiki Industrial, Co., Ltd.

Mr. Shishido's major claim to fame is the Inverted Interstage Transformer (IIT) circuit, a design that has become known as the "Shishido amplifier" in honor of the inventor. This genius circuit topology allows husky directly-heated triodes originally designed for Class B and Class C RF applications to go to work in Class A single ended circuits. These industrial-strength transmitting tubes can provide real world power levels, they are super well made, and they are objects of great beauty to the discriminating eye. Furthermore, the cost of such tubes is reasonable by contemporary audio standards and NOS availability is good.

Shishido amps typically employ a power tube driver stage coupled with a step-down transformer to the grid of the transmitting tube. A regulated *positive* DC bias is fed to the grid through the secondary of the transformer. Power grid tubes are designed to be run under grid current conditions and this class of operation is linear, efficient, and capable of high power output while retaining the musical superiority of SE DHT circuits.

The WAVAC 805, Yoshiki's flagship product, is a 50 watt using the classic RCA 805 triode in the patent-pending IIT configuration, a beefy triode-wired 6L6 driver, and a WE 437A input tube. The WE 437A developed for wideband telephone amplifier applications in the 1950s, is arguably the ultimate small signal tube ever installed in a glass envelope. Clearly, these guys did their tube manual homework.

The WAVAC amplifiers are NC machined out of solid chunks of aerospace-grade aluminum and fitted with a heavy glass canopies. The tube sockets are milled out of teflon. Top class all the way. Overall, the WAVAC amps look like work-of-art $1000 per watt amplifiers. Hope I get to own something that nice before I die, but if I have to build it myself, it ain't never gonna happen!

Shishido's approach has been a real hit among Japanese DIYers over the past 10 years. His 1992 book, *Sohshinkan niyoru Single Amp Siesakushu*— Single Ended Amplifers with Transmitting Tubes— sold over 5000 copies in the Japanese market. [Seibundo Shinkohsa Press, ISBN 4-416-192209-6 — Available from April Audio in NYC or Nippon I.P.S., the overseas *MJ* distributor, fax:+81-3-3238-9046 Attn: Miss Y. Muramatsu.] This volume contains IIT circuits using 830, 811, 808, 838, 8012A, 826, and an 805 circuit similar to the WAVAC 805. Shishido's classic passive EQ 6DJ8 phono preamp circuit and his famous Loftin-White style 2A3 circuit that opened the door to SE back in the 70s, are also included. I should have studied Japanese instead of French.

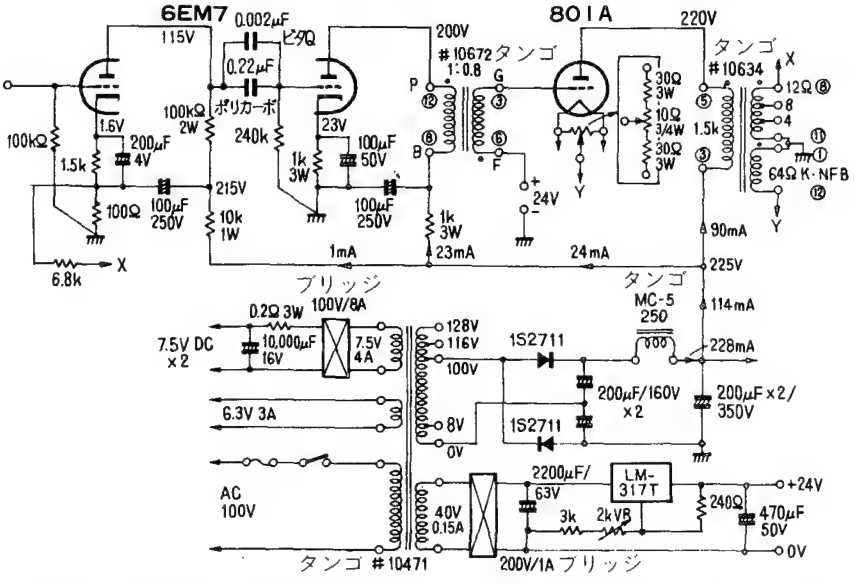
I recently built the Shishido 801A IIT amplifier to get an idea of what's going on with this stuff. The 801A is not the king of audio tubes for regular circuits. It's good for a meager 1.8W in typical Class A operation, requires a hard-to-get high impedance transformer, and it tends to sound a bit thin and wiry anyway. In the IIT circuit, the 801A puts out a reasonable 8W and sounds totally



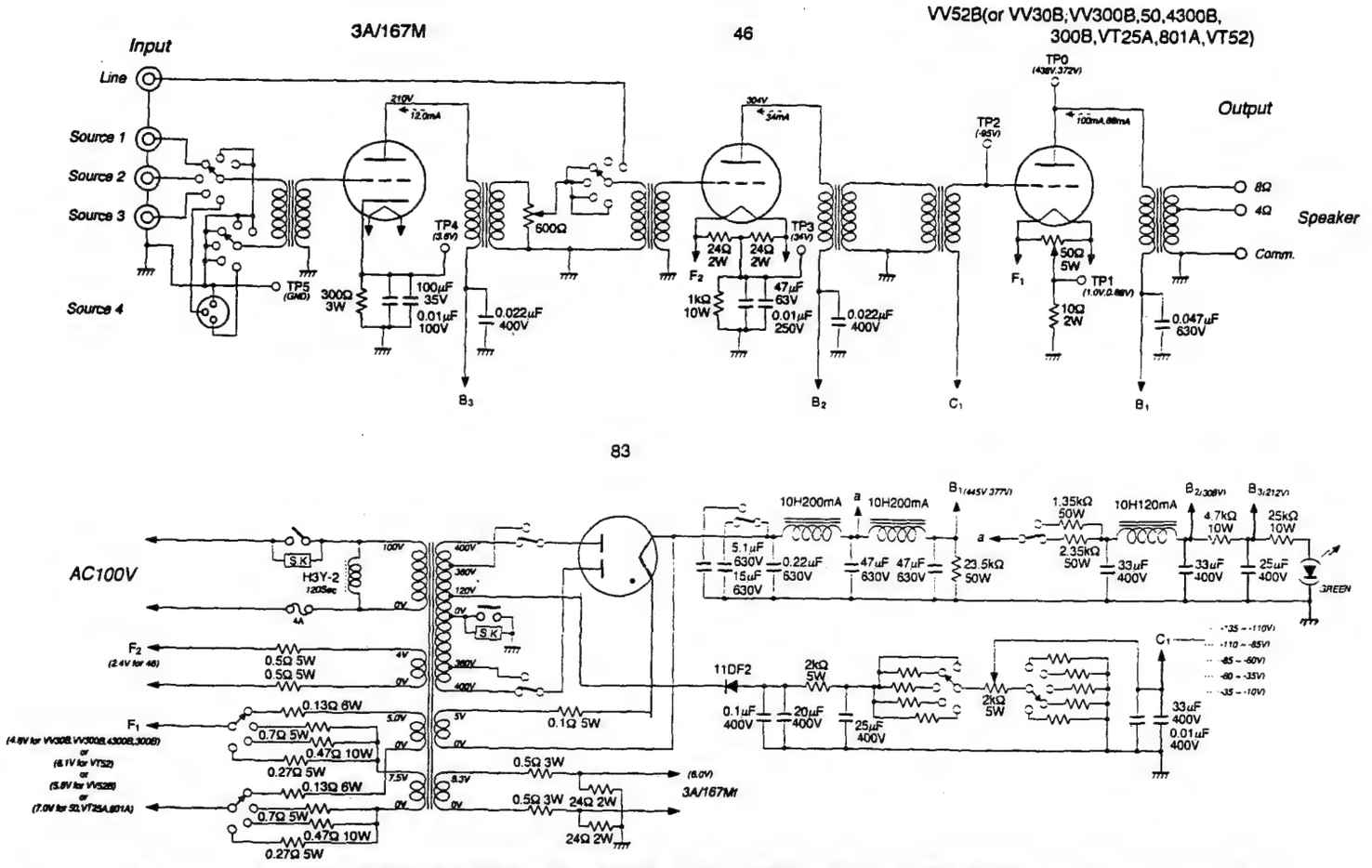
International Triode Mafia
Qvortrup, Reichert, Shishido

natural and transparent with a powerful and punchy low end. As Nobu told me, "We use some concepts with a connection to old romantic days, but I am interested only in the most modern sound for today's listeners."

As the 801A IIT schematic indicates, the grid of the output tube is biased positively and the plate voltage is kept low, consequently the tube operates in a grid current mode. The secondary of the interstage transformer provides a low DC resistance path so



Nobu Shishido's 801A Inverted Interstage Transformer Amplifier





the voltage remains constant with variations in grid current. The interstage transformer is a special air-gapped design that features a step down ratio for low impedance drive to the grid. At +24 grid volts, the 801A curves in the RCA manual are ruler-straight.

Clearly, the WAVAC amplifers are intended for a special class of devoted audiomaniacs whose bank account is a big as their love of audio. Several WAVAC creations are currently in the hands of Stateside reviewers, so we will get to read more about these fancy amplifiers in coming months. For the "rest of us," forced by mortgages and grocery bills to forego the luxury-class industrial art of Yoshiki Industrial Co. products, take heart that you can homebrew your own humble version of the Shishido IIT amps for less than the cost of a new Toyota. Long live DIY.

TRIODE SUPPLY JAPAN also weighed in with a high mass transformer-coupled mono SE amp called *Plenteous*. I suppose the name comes from the fact that there is plenty of iron on those babies— count 'em, TEN miscellaneous transformers and chokes per side, all painted a show-stopping vibrant green!! Cool! Heavy!

The *Plenteous* is set up to run plenty of different output triodes also. Adjustment switches are provided to allow the user to dial in the plate voltage, filament voltage, and bias voltage as required. This colorful creation sounded very smooth, distinctive, and alive with that big VV52B plugged in the socket. The *Plenteous* is available direct from the manufacturer for $9800/pr.

Only six months after the SVETLANA SV-811-3 power triode hit the market, the brothers are already putting it to good use. I ran into George Badger of Svetlana at the show and after hearing a few of the amps burning the new Russian firebottles, he was really impressed with the whole tube audio scene. Being an old radio guy, I'm sure he thought we were all nuts just a year ago but he didn't realize how crazy we really are. More tubes, George! Arf arf!!



AES SE811 Monos



The new Edgar Lineup

For example, **AES/CARY** just introduced a SV811-3 mono amp called the *SE-811*. This 12 Watter features a beefy "screen-driven" 5881 driver and it sounded like they were driving this tube right into a pair of lead-lined Focal-based prototype loudspeakers. According to Dennis Had, the *SE-811* might ultimately be available in kit form, so be on the lookout.

Those hometown Vegas transformer-winders from **ELECTRA-PRINT** had several sharp-looking SV-811 based amps. The 50 Watt *Vershina* really showcases the brilliant white glow of those thoriated tungsten SV-811 filaments with four parallel SE power tubes per side. This $10k a pair, 85 pound monoblock is class all the way, down to the gen-u-ine 24K plate on the transformer end bells. Of particular interest to the DIY community, E-P serves up full and partial kit versions of two of their SE amplifiers, the $4300 eighteen-watt stereo *218EP* VV30B amp and the $3200 stereo *210EP* SV811-3 ten-watter. Being crazed experimenters themselves, Jack Elliano and Cy Brenneman love to work with fellow DIYers looking for a worthwhile project. Aside from the considerable therapeutic and educational value of building a kit, you can save over half the cost of the assembled versions by soldering your own connections. Gold plate optional.

Several new species of **EDGARHORN** were on hand at the show. Photo shows three Edgars, the *System 50*, the *System 80* and *Bruce* himself. The second-biggest Edgar is the $10K two-way that Bruce engineered as an answer to all the "fancy European stuff" that's coming out these days. The circular wood-horned compression driver HF was big and smooth on vocals. Wood is definitely the ticket. Forget those amusical cast aluminum airport paging horns. Low end is handled by a 50 Hz wood horn of substantial proportions.

The System 80 is a 42"x 19"x 18" integrated horn setup with a 5 foot long folded tractrix 80 Hz horn, a 5" JBL mid on a 400 Hz tractrix mid, and a tractrix horn tweeter. Designed for against the wall placement for bass reinforcement, incidentally making it an ideal horn solution for installations where floor space is at a premium. Whopping two watts recommended minimum power at 103 dB 1W/1m system sensitivity. Popularly priced at $1200/pr. Watch out, *La Scala!*

CLASSIC AUDIO REPRODUCTIONS added a new horn rig to their collection of fine furniture neo-classic horn loudspeakers. The *Studio Standard* is a three-way system based on the design principles of the legendary *Hartsfield*, featuring a 15" woofer crossed over to a JBL titanium diaphragm compression driver fitted with an acoustic lens topped off with a wide dispersion HF unit. The smaller, more rectangular footprint of this system is an advantage over the Hartsfield in some setups. Sensitivity of this $6350 system is a roaring 103 dB 1W/1m.

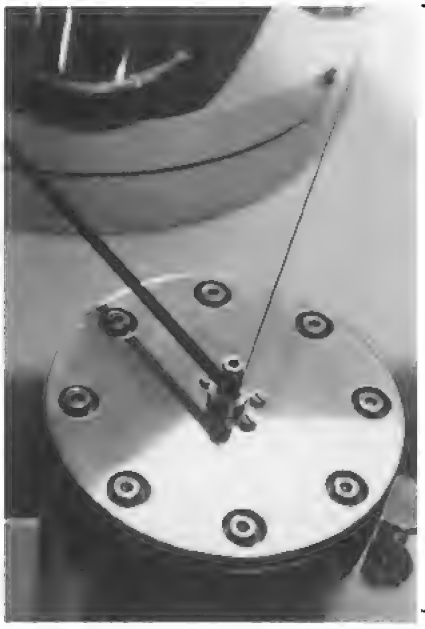
These diehard JBL nuts were also demonstrating a killer "bookshelf horn" with a JBL mid/high horn and a pair of fancy imported 6 1/2" inch woofs. Called the *Cinema Music Channel*, these 96 dB 1W/1m, 8 ohm speakers are being presented as a home theater accessory, but they sure sounded powerful and hearty playing rockin tunes on 8 watts from a *Cary SE-1*. Suggested list on these sleepers is $2030/pr. He might not remember the conversation but after a couple beers at the *Fi* party, John Wolff offered to extend a very special introductory deal to *SP* readers to get 'em started on horns. I'm your witness . . . operators are standing by. . .

Classic Audio Reproductions
515 Red Fox
Brighton, MI 48116
810-229-5191/810-229-5969 FAX

In five pages, I can only explore the tip of the thermionic volcano that was CES '96. Also worthy of note were the **BEL CANTO** 845 amps, **VAIC VALVE AGs** corral of luxury SE amps, the **N.E.W.** battery operated preamp, the French **AUDIO SCULPTURE BY AUDIO MATIERE** amps that run single 845s with a triode-wired 813 that kicks in when extra power is needed, the **MPR** SV811 amps from that hotbed of tube experimentation, Italia, and on and on. Consumer Electronics Shows are always full of new products. What made this year different for me is that with all the fresh spirited action that went down this year, I'm actually looking forward to Vegas '97! Unbelievable.



Classic Audio Reproductions' stable of horn speakers



TURN YOUR TABLE

by Dr. Götz Wilimzig

"If you are going to be an egghead, you might as well be a hardboiled one."

Ursula K. LeGuin

Would anybody enjoy a sports car engine producing shake, rattle and roll? Or do we expect smooth action up to the highest speed of rotation? The stock DC engine supplied with my hundredandtwenty pounds of turntable is a common 12V type made by Philips. Rotated at 7 to 12V without any load it forced my hand to vibrate. At the time I knew nothing about high quality motoring but I simply couldn't believe in vibrating engines as an optimum solution. Thus began my search for a real high end driving unit.

There exist some simple tests to determine if this story is for you too. Please stop reading if you insist on feeding a synchronous engine with AC. They're always vibrating like hell. I am familiar with TD 124 and listened to EMT work horses. Yes, I like oldies, goldies, and all of you giving the highest reputation to old German professional turntables. Later on you will find some reasons why a synchronous motor can't be the best choice. And yes again, I do know how amazing antiques sometimes reproduce music. But there have been strong faults too.

Remember the rumble of wheel driven tables, remember that call for "nothing below 40Hz on our records"? Two friends of mine are riding old TD 124s. Both prefer hearing my modified turntable.

Quality check

So let's start testing that unknown motoring. You have to measure the voltage your engine needs for 33 RPM and 45 RPM. Furthermore, a regulated DC supply is necessary, take that one in your laboratory. Remove the DC engine from your turntable and feed it through your lab voltage regulator.

First test. Increase voltage from zero to the manufacturer's limit. (It should be given. A DC engine of quality can be driven at higher voltage a short time without damage. Usually maximum is within 6 to 24V.) Does the engine vibrate in your hand? Well built ones will run at more than 10,000 RPM absolutely smoothly.

Second. Click the engine on and off feeding in the working voltage for 33 RPM. Repeat this test for 45 RPM. Do you feel when it's clicked on? Does it cause any reaction when starting? Does it "jump" in your hand?

Third. No electricity necessary for this one. Remove the pulley. Hold the engine in one hand. Place the shaft between thumb and forefinger of the other hand. Now move one finger forward, one backward, and vice-versa. Thus shaft and rotor have to change their turning direction back and forth. Do you feel any moment of inertia acting against changes of direction?

Fourth and last. Remount the engine. Use manufacturer's supply as usual. Hear some records. Then switch over and feed the engine through your lab voltage regulator. Listen again. Do you notice more detail, greater dynamic range, increasing low level performance, less muddled sound?

The right answer is always "no". If this happens to you: congratulations! You're the lucky one. I bet most of you will answer one "yes" or more, no matter how expensive the turntable was. From my experience engines in conventional turntables are simple, reliable and cheap, but not at all sophisticated, high quality or high end. So we have to look for technical improvement by ourselves. But is it really necessary?

First link in the chain

Getting music from vinyl sometimes comes along with a slight misunderstanding. Lots of audiophiles take for granted that picking information out of the groove is the first thing done in their chain. Audiophilism believes in dream cartridges. This isn't wrong at all. It's just the smaller part of the truth. The second part.

Any cartridge simply will reproduce the information presented by the turntable. Cartridges alone can't read music. They'll take every fault of the platter as a signal. And there are faults. The music encoded in the groove can be transformed to music again only if the driving unit gives the most accurate speed to your platter—every microsecond! The more precisely the platter moves, the more music you hear. This is the awful truth.

Nevertheless audiophiles upgrade their systems buying very expensive cartridges. Of course this varies the sound of the system, as the salesman promised. A new and different exhaust pipe will alter the sound of your car too. Does that convert any vehicle into a sports car? Maybe your car finally will be able to win a race. Asking for this you can't be wrong to call Roger Penske for better motoring instead of buying pipes at your local dealer.

The heart of a sports car is the engine. It's the heart of your turntable too. And why not go for the best? Building a new driving unit yourself will not only renew the very first link in the audio chain, it also will bring you a thrilling experience. The experience of getting deeper into the music. That might be worth some labour.

During the last decade I heard and reviewed a number of turntables. Can't remember them all. There is no one with a DC engine of precision known to me. Most manufacturers are driving the platter with cheap engines and try to decouple them using a rubber or plastic belt. The vibrating energy of the engine floats into the belt. Construction theory says this energy could be neglected.

Now imagine a vibrating, springing belt—is it really the best in giving ultra smooth and most exact performance to the platter? Some audiophile turntables use string instead of a belt. It may cause less vibrating energy and better decoupling, who knows. I tried dozens of strings, becoming the best known non-fishing visitor at my local fishing shop. Yes, all those so called audiophile strings like Kevlar, Dyneema, etc. are constructed for anglers. I even tried grandma's sewing cotton, but never was satisfied. Maybe some strings minimize vibrating problems. So you lose one problem and win another one. The area of contact between a pulley and a string is unbelievably small, all strings slip. The rotation of the engine isn't really translated to the platter as it should be.

Newton's Law

For evaluation it was inescapable to go back and start with a basic question: What happens to a platter in action? What's going on in those short times we can't spy?

Well, let's say the diamond is in the groove and the groove is moving at the right speed. First signal comes. Just for simplicity let's assume it's a sine wave. Following this wave the diamond has a friction. And the friction is different as each part of the sine wave is different. Any friction acts as a force speeding down the platter. The amount of force depends on the signal. (And individually on the shape of the diamond and the pressure the tone arm gives to it. But we're talking general rules now). The greater the friction is, the more force is generated; furthermore the faster the diamond has to pass through the sine wave, the greater the force.

Newton's Law describes the relation between force and change of speed. It's valid till now.

$$F = m \times b \quad \text{or} \quad F = m \times dv/dt$$

F is force, m rotating mass of the platter and b or dv/dt is acceleration or change of rotating speed. It doesn't matter if the acceleration acts speeding up or speeding down. For a given mass of the platter the change of speed depends on the force. There is no possibility to avoid a "braking" of the rotation if a force arises.

This is essential: in the act of playing records, your platter will lose some speed, no matter what we do, no matter how good the driving unit is—the rotating speed is always going down a little, depending on the movement of the diamond.

Regarding Newton's Law increasing the platter's mass will minimize the change of speed. This seems to be the nicest idea, and indeed there do exist some turntables with high mass platters. But wait a minute. The loss of energy ΔE is:

$$\Delta E = .5 \times m \times (\Delta v)^2$$

with Δv being the amount of lost speed. The driving unit has to counteract this loss of energy which grows with the platter's mass. This isn't easy to do for the engine as will be exposed.

So in reproducing a single sine wave the platter changes speed from microsecond to microsecond, destroying the original phase. It's possible to pick up the amplitude of the signal as encoded in the groove, but it's impossible—and always will be—to get the right phase relation, because the actual speed of the platter is changing with the signal. There will be errors of time, and to do our very best we reach out to use the engine and the whole driving unit to reduce them.

These special errors are the birthmark of the turntable. Keep that in mind, please! Therefore it always has been good advice to listen not only to vinyl, but to a good tuner and tape recorder too. And the best advice of course is to listen to original music. Transporting the tape may cause mechanical faults, but they are not in the least dependent on signal. That's the difference.

Welcome to the real world

Seems a little bit strange to me that these birthmark faults never have been realized by measuring technicians. Nevertheless it's true. Till today there are serious measuring faults related to the platter speed, but speed alone doesn't mean a thing. It would be necessary to compare time errors to the original phase, whereby they will be translated into a correct magnitude. As far as I know this never was done. Being without correct measurements we should follow Newton's law and try to improve the driving unit to our physical cognition. There is no other way to improve our turntable.

Electrical engines don't think. To react to anything the engine must have seen an action first. The only action we can give to it is the platter's decreasing speed of rotation. This has to be translated to the shaft of the engine, and to realize this is a big problem requiring an optimum connection between platter and pulley. If the string or belt runs at the outer side of the platter and the pulley has a size of 9mm, the pulley's speed of rotation is above 1,000 RPM. The contact area on the pulley is very very small compared to that on the outer ring of the platter. Therefore every slip will occur on the pulley. If the platter's speed is going down within microseconds, there is a huge risk to cause slip on the pulley— unless we find an optimum connection between platter and pulley.

Going back to our sine wave again the greatest force is given to the diamond within the first twelfth of the period. There it rises to half of the amplitude approximately as a straight line. At 1kHz this twelfth is passed by in 83 microseconds. The change of speed just happens at the same time. To transport platter speed variations to the shaft of the engine, the material of the string or belt has to be absolutely stiff. Any elasticity will prevent the translation of high speed movement to the pulley within microseconds as required.

Additionally, the belt material should offer the greatest possible contact to the pulley, giving not only a good grip but a big contact area too. I couldn't solve this problem for some years. Then my friend Alex once asked me: "Why don't you use this?" And the flashlight of a fascinating idea dazzled my brain. The idea shows up a stunning simplicity, seems to be the product of real genius. And the material is well known to audiophiles all over the world. Why don't you use *recording tape*, Alex asked me. I did. From that time on professional tape of 6.25mm size has been running on the outer side of my platter. And I'm satisfied. Believe me fellas, this it is. If you don't believe it: try it.

You'll have to look for a cylindrical pulley of 7 to 9mm diameter with a rim at the lower side. Adjust the axis of the engine in parallel to the axis of the platter. The adjustment should be brought to precision. The tape will run properly without an upper rim.

Hunting for engines

To follow the platter's motion immediately the rotor of the engine must have a moment of inertia of zero. This is what physical science demands. They can't build it, yet it forms the first and most important condition to choose an engine:

(1) The rotor's moment of inertia should be low low down.

That's why all engines with high mass rotors like synchronous engines don't fit. They can't follow the platter's motion.



Author's Platine Verdier with recording tape belt and new motor

First condition fulfilled the second question arises. How should the engine react? Losing speed is a fault we must try to minimize. Therefore a regulating engine would fit best. An electrical regulator increases current in case the voltage decreases. The right motor should produce more torque if the speed of rotation is lowered. This reaction is valid as well for those changes of speed coming in slower motion and—hurrah—there does exist one fulfilling this specification: the DC engine driven with constant voltage.

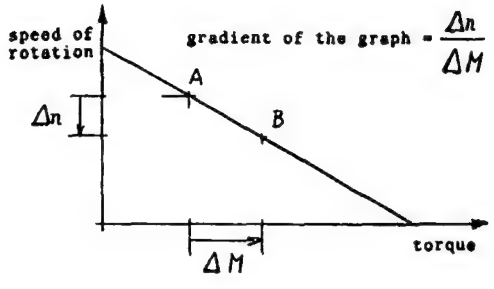


Figure 1: DC engine at constant voltage

Figure 1 describes every DC engine at constant voltage. For 33 RPM it is running at point A with more than 1,000 RPM as recognized above. If the platter is lowering speed by Δn, the engine goes to point B and rises torque by ΔM. The quotient Δn/ΔM is constant and a describing datum for an engine. It is the gradient of the graph and is given in 1/min×mN×m (mN = milliNewton and m = metre). The smaller the value, the stronger is the engine. (The wattage doesn't matter. It should not be exceeded. We never will. So don't ever choose an engine judging on wattage). Thus we have the second condition:

(2) The DC engine is a real must. Without any exception.

(3) Look for a strong engine, specified by a low value of Δn/ΔM.

Unfortunately this is contradictory to (1). So we have to vote for strength or for a low moment of inertia. Voting depends on your platter. If you prefer a high mass platter you have to go one more step for strength.

To diminish the errors of speed the engine has to pull back the platter to 33 or 45/min. It should do that like a rocket. We are looking for a sprinter reaching his speed in the shortest time, Carl Lewis would be just right. Some manufacturers publish data regarding how quickly the engine runs up to 63% of its maximum speed of rotation without load. So:

(4) Run up time has to be short. Imagine Carl Lewis is leaving the starting block.

These are four fundamentals. There are some more conditions to complete our first look at the engine and add a little background to pick up the place.

Crucial choice

Till now we have been discussing only concepts we can't see. Remember we're dealing in microseconds. Whatever happens to the platter within this time never will be visible to the human eye, it's too fast. Every look at the stroboscope desk will fool you with an average speed, even if this average is indicated with reasonable precision.

As we've pointed out the platter is flickering around its average speed, falling down a little and being pulled up by the engine again. This is the other, the invisible reality. Of course there are connections between both worlds. The DC engine running smooth at an average speed most probably will be smooth at quick action. So we have to look at the visible too, concentrating on four items. There are more, of course, but this isn't a quick run on constructing engines.

For audio use, low noise and smooth action are essentials. Every engine built by man causes vibration and noise since they can't produce them at zero tolerances. The biggest part of the problem is generated by the bearings. Therefore:

(5) Choose sintered bronze bearings for quiet and smooth action.

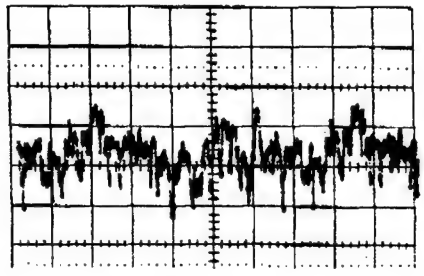
Pulling aside the belt creates a radial force acting on the shaft of the engine. Strings always cause the greatest radial force, tape much less. So:

(6) Ensure the engine's maximum radial force will not be exceeded.

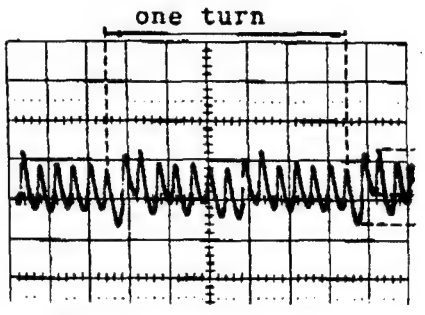
Points 5 and 6 are somewhat contradictory within engine design. Ball bearings can tolerate a greater radial force but are much noisier. Regarding bronze bearings, the radial force is diminished with the diameter of the engine. That's why engines of small diameter are not always the best choice, even though they are best in terms of a low moment of inertia. We live in a contradictory world, all we can settle for is a well-sized compromise.

We'll finish with two electrical items. The DC engine has to be driven through a built-in commutator. The current reaches the coil by passing across that commutator. And commutators cause spikes (see Figure 2).

(7) The brushes of the commutator have to be precious metal ones. No graphite allowed here.



Graphite brushes



Precious metal brushes

Figure 2: Spikes caused by commutator

To get constant voltage we'll need a regulator. For practical reasons it would be nice to make it adjustable. The DC engine's speed of rotation is determined by voltage. Therefore the voltage has to be adjustable with great precision and stability.

reference (see text)	parameter	unit	recommended	dc-engines #1	#2	#3	#4	#5
(1)	moment of inertia	g x cm^2	up to 10	0.5	2.5	8	8	10
(3)	$\Delta n/\Delta M$	1/min x mN x m	100 to 1000	1,300	1,000	200	200	40
(4)	run up time	msec	5 to 25	7	23	17	18	5
	to turns	1/min	2,000 5,000	11,000	5,000	4,000	5,000	7,000
(6)	maximal radial force	N	1 to 5	1.5	3	4.5	4.5	16
(8)	turns to voltage	1/min x V	150 to 400	500	200	200	200	200
none	nominal power	W	up to 10	2.5	2.5	4	6	20
	at turns	1/min	up to 10,000	17,000	8,000	6,000	9,000	10,000
none	diameter	mm	13	13	26	26	26	25
	length	mm	33	33	45	45	45	55

Abbreviations: cm = centimetre; g = gram; min = minute; mm = millimetre; mN = milliNewton; msec = millisecond; N = Newton; sec = second; V = volt; W = watt.

The engine manufacturer should publish the ratio of turns to voltage (given in 1/min x Volt). If they didn't, you can find that value dividing the maximum speed of rotation by the maximum voltage.

(8) Make sure the engine will perform optimally with an easy to build regulator.

If you never have looked at manufacturers' data before, you should allow yourself a little training before buying a new engine. I want to show up some general data combined with realistic examples, completed with a comment on each example. If you're familiar with electrical engines, the columns containing numerical values might still be of interest to you. Please notice European units.

Comments on Engine Parameters

#1. Gorgeous, this pen size engine: 17,000 RPM. Hunting for a low moment of inertia only, this would be the one. Good for ultra short run up time, but this engine is the weakest of them all at carrying any load, as indicated by the $\Delta n/\Delta M$ quotient, which in my view is too high. (Most miniaturized engines are ordered with a gearbox to adjust it to the speed and torque wanted; but any gear means more noise, more rattle, more bearings, more tolerances...) The turns to voltage ratio is a little bit unpractical, this one has to be driven at 2.0 to 2.5V. Furthermore there are problems we didn't mention. Corresponding to the reduced diameter this engine comes without a thread and will be difficult to mount. There is a shaft of 4mm length and 1.5mm diameter to fix the pulley—once again a little bit unpractical. (A lot of these pen sized beauties come with toothed wheels ready mounted). All these are reasons to look for another.

#2. This one offers the same wattage at a more convenient speed of rotation. The turns to voltage ratio sets #2 (and the following ones) at an easy to regulate five to six Volt margin. Run up time is a little bit on the limit, yet I could live with this. Radial force is high enough to pull the most stretched string. This feature promises an extended lifetime. Summing up you could use the engine for a low to medium mass platter, for example a Roksan, Thorens TD 126 or Linn.

#3. The moment of inertia is raised. The $\Delta n/\Delta M$ quotient shows a stronger engine. Given the same loss of speed this one will put out a torque ΔM five times higher than #2. In real world DC engines there is no way to combine the low inertia of #2 with the greater strength of #3. You have to vote. The shaft offers 3mm in diameter and enough length to mount any pulley with ease. (This is the same for #4 and #5). Added the high radial force this one will run properly with high mass platters.

#4. The brother of #3. But not big brother. All values are equal except run up time, which is comparable. There'll be no differences in practice except one. The higher wattage is realized conceding a higher speed of rotation. To reach this without losing lifetime the manufacturer changed the brushes of precious metal versus graphite ones (see figure two). Don't be misled by the nominal 6W rating. Go for #2 or #3.

#5. The muscle car. Lots of power. Quick. Strong. This is doctor's choice to cut your bones if necessary. It's for medical saws, etc. Supposing doctor is a speedy cutter the engine will resist up to 70W (!) as short time overload. It's built with the hardest ball bearings to stand double speed of rotation. And graphite brushes of course. Doctors don't ask for smoothness. So very sorry, powerfreaks, thinking big not always cures problems. Small is beautiful. Constructing an unique 211 amp of 15W, John Camille finally discovered that 50 to 500mW was all he ever needed. Driving your platter the DC engine doesn't consume a higher wattage. (If it does there is something wrong with your table; check the main bearing; renew the whole turntable).

Following the route

It would be fine to detect one manufacturer offering such an assortment. More often you will find only one piece—or none—worth considering. Maybe there are half a dozen specialized in high precision DC engines, maybe more, I don't know. They're not at all accustomed to handle high end freaks. They're looking for "normal" orders starting with one hundred pieces. Asking for only one you have to fight your own way through that business jungle. Yet it's worth the labour.

To complete the driving unit the engine has to be mounted. I recommend an aluminum plate of 1/10 of an inch. Place this on top of a metal case of at least 10 pounds. And decouple the mounting plate, but don't apply rubber or anything like that. Remember the pulley has to stay parallel with the axis of the platter—no motion allowed here.

Furthermore you'll need a DC regulator. Listening to a turntable driven by a DC engine of quality you will notice unbelievably small changes in the regulator's design. Take care. If your engine is the best, the regulator has to be in the same class. Look for parts of highest quality only and keep in mind that you're building a supply for a very few milliamps. Anybody out there specialized in those regulators?



Platine Verdier installation of Christian Rintelen, *Hi-Fi Scene* Editor

Bringing together the whole unit you should work like a clockmaker does. Take an artist's look on things. Any resistance in a no compromise preamp isn't just resistance, it's a special one. It has taken time, experience and a long way of searching to bring it up to the best. Fixing your engine and mounting the driving unit you should do the same in choosing screws, washers, etc. There are no parts of minor importance. If your system is up to the standard, you will hear the smallest difference. So we reach the final question: How does it sound?

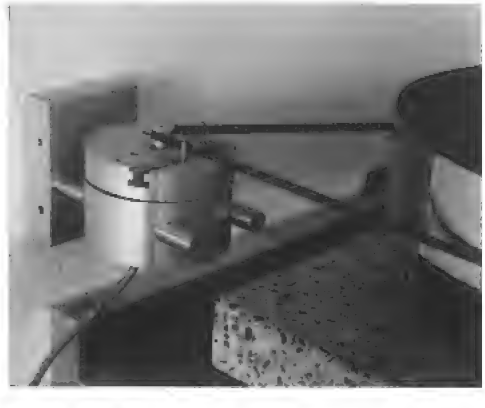
Last not least

To start with a confession: I'm not really an audiophile. Audiophiles end up hearing 300 to 500h hifi a year and about 3 to 5h music by chance. I'm on the opposite side. Three members of my family play, so I'm hearing natural instruments at close range in average living rooms every day I'm home. I don't listen to hifi every day. Adding up a year there'll be as much music as hifi. Everything I ever tried was to minimize the huge difference between hifi and the original thing.

A well built driving unit leads one step closer to the real thing but I don't know if you'll be pleased. Maybe it will sound nasty. For example, if there is a SME 3012 and a Denon 103 it definitely will. Because this combination isn't at the same level. Maybe the faults within your system will be pointed out much clearer. Undoubtedly there will be less time errors, better phase relation, better transients, more pulse, more low level detail. There will be more music. Once again, I can't predict your view. Those who tried call it a big step forward.

Of course you can adapt this driving unit to sort of a Thorens 125 but, obviously, the better the turntable the better it will match. I like it with a Platine Verdier. My turntable carries a Series V and an Ortofon Vero, followed by a step up transformer, an all the way 6922 preamp and a pure triode SE amp. I just kicked out my former 300B Legend (by *L'Audiophile*) after modifying it for some years. The amp drives a DIY one way speaker of high efficiency based on a Siemens driver mounted in a vented box.

Using a highly evaluated system you should compare a driving unit such as I describe with any manufacturer's solution. You'll need only very few seconds of the first track on a Jennifer Warnes record to get clear. That's what I want to say.



Wall-mounted motor unit

Postscript

John Baier and Herb Reichert proved the TD124 to be great. They're right. J.C. Morrison goes for Garrard 301. He's right. Vinny Gallo loves EMT. Just wonderful, Vinny. All these guys vote for turntables of the other party. They use wheel drive and really big engines ignoring every quick move of the platter. And here's yours truly pointing out some rare ideas of flickering platters et cetera. So what's right, what's wrong?

All these jurors are doing an excellent job. I'm right on their side bringing back to our knowledge that once components were built to better than today's standards. I always admired that deep sense of craftsmanship delivered in those goodies. Yes, I love oldies.

However, take notice that none of these was ever constructed to serve other than professional needs. Keep them running, that's the idea. For example, EMT's tonearm and cartridge and Ortofon's famous 309 and SPU were designed to work under worst case conditions. Life was tough at radio stations —and still is. (Two interesting years I lived with the latter combination). No audiophile touch there. Audiophilism should ask for optimum conditions to reach and stretch out the limits. That's a different approach. It's my approach too, looking at the turntable in a focused manner.

Working out a new idea always breaks some old practice. Nobody is accustomed to call for DC engines of highest quality. Nobody usually thinks of ultra-fast motions happening to the platter. You are trained to believe in electrons you can't see or measure. Yet you believe they exist. You believe in electronic waves and you believe in audio signals you've never seen that are said to be inside your amps. And first and most important they're in your brain. Till now any quick action of your platter wasn't in your brain. It's not at all surprising that you doubt if a flickering platter could be real.

Yes, it's real. It goes back to old cognition found out by Newton (1643-1727). Till now Newton's Law is valid. Physicists up to Einstein proved it. Given the conditions of our physical world, this is the truth—or as close to the truth as man can be. If your pen is falling down it's following Newton's Law. If your car is bumping up and down it's following Newton's Law. And your platter is flickering around its average speed following Newton's Law. As long as signal in the groove is changing there doesn't exist any millisecond during which your platter is moving at a constant rotation. Therefore it's

(Continued on page 43)

TURNTABLES (continued from page 14)

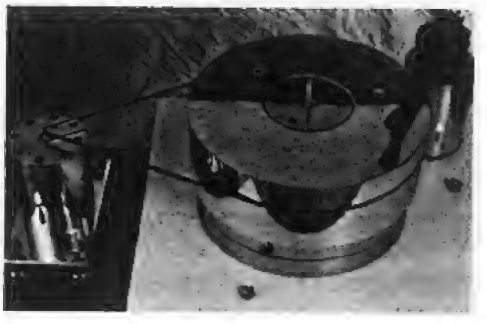
the audiophile way to construct a driving unit to minimize these errors.

After using a Platine Verdier for six years now, I definitely lost that down-to-earth feeling. I wonder why so many American freaks creating great amps and speakers never felt the necessity to match them with a high-end turntable. Bringing a 300B amp to perfection or taming a VOT— is that down to earth or up to audio heaven? Anyway the best advice I can give to you is:

1- Sell any Garrard, TD 124, and, in my humble opinion, Linn, or place them in your private museum. Don't mess up those old goodies!

2- Start with a Xerxes by Roksan, if you don't want to jump forward to a Platine Verdier. Xerxes still has one of the finest bearings I've ever seen in a commercial product. You can buy a bearing and inner/outer platter assembly from Roksan and mount it on a subplatter of your choice [Roksan distributor in US: May Audio Marketing, 423-966-8844/8833 FAX. Approximate cost of platter and bearing is $600).

3- Find a good engine or use the Swiss-made 24V Maxon part # 2326 942-12-111-050 [available at $231.10 in single qty. from Maxon, 838 Mitten Road, Burlingame, CA 94010 415-697-9614.] You can try the much cheaper "941" 30V version if you are confident that you can build a low voltage regulator. Christian Rintelen of *Hi-Fi Scene* uses the rare and expensive "949" 42V version. The Maxon is #3 in my chart and it will serve as a classic in all applications. Avoid Pabst.



Realization of Audio Contact, Germany

4- Try a home-spun driving unit as described above, using tape as a belt. The optimum tension is where the platter runs at the lowest voltage. Use the best pulley you can get, even if the cost is excessive. For the Maxon motor, I recommend a pulley of 9mm diameter. Audio Contact in Germany can provide a ready-built pulley of this size and they also sell engine/pulley systems. (Audio Contact, Lindenweg 12a, D-22395 Hamburg, Germany).

5- Build a variable regulated power supply which can be as simple as an LM 317 chip or as complex as you wish.

That's it! Most probably this will outperform 301, 124, LP 12, or whatever you name. If you're out for the top turntable, you will have to build it yourself. That truth is simple and always the same. I'm sure you can do it and without becoming a mechanical engineer.

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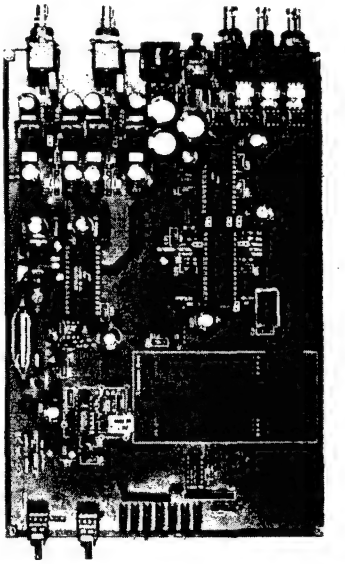
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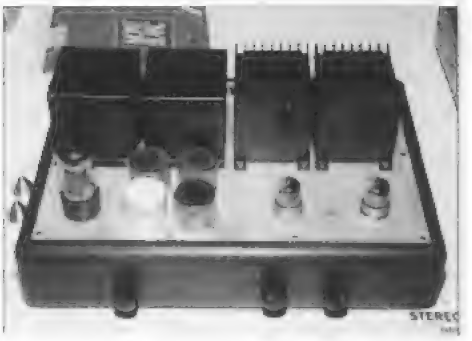
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EURIDICE

A TRANSFORMER OUTPUT LINE LEVEL PREAMP



BY CIRO MARZIO, CRISTIANO JELASI & LUCA CHIOMENTI

A single ended transformer output line level preamp could in this day and age seem a bit strange. For sure, this concept is unusual in the Western audio scene either as a commercial product or aunique DIY item. The fact that this topology is uncommon in the contemporary hi fi scene does not mean it is anything new. In fact the basic circuit is not very different from the one used in the famous Audion—the first audio amp ever built back in 1912.

In the early years of audio the standard amplifier stage used a transformer at its input and a second one as an output device. The latter could be ud either to drive a speaker or as a coupling unit to the next amplifier stage. Batteries were used everywhere in power supplies.

Resistance-capacitor coupling appeared in 1916 but it was seldom used since a big amount of the precious energy supplied from the batteries went wasted in the plate resistor. RC coupling has lower gain than transformer coupling and adding more amplifier stages to compensate for the lost gain would increase battery consumption more and more.

In those years, transformers with a step up ratio were the norm since they provided voltage gain without power consumption. With the advent of AC power lines and early high μ triodes things changed. RC coupling became practical since batteries were no longer the primary source of power. Gain became much less expensive with AC electrification. Yesterday as today, economics plays the major role in determining the course of mainstream design. Cost usually wins out over quality.

Modern high permeability low loss magnetic materials were not available so the construction of high quality transformers was very difficult. But it is astonishing that with modern capabilities, transformer coupling is so seldom used. After all, transformer coupled circuits were a mainstay of the highest quality professional studio gear through the 1960s. How did contemporary hi-fi design get so overspecialized and banal that a simple classic transformer-coupled circuit appears totally revolutionary?

We started this project a couple of years ago in Milan. It was a pleasant September night and we were eating and drinking after a very hard working day at the *Top Audio* Show. Almost the whole staff of *Costruire HiFi* was there talking and chatting. After a very short time the conversation turned to audio and music and somebody asked us our point of view about preamps. We started talking about a hypothetical transformer-coupled preamp and after maybe half an hour and a couple of glasses of Italian red wine we decided to build one.

We love the living natural effortless sound of single-ended amplifiers so we chose this design topology. Despite its apparent simplicity designing such a stage is everything but easy. In a plate loaded configuration, a single-ended stage has an output impedance practically identical to the active device internal resistance. Most of the commonly used signal triodes have a plate resistance of several kohms. It ranges from 2-3 kohms of the 6DJ8 family through 6-7 kohms of the 6SN7 and 12AU7 families up to the 60 Kohm and more of the 6SL7 and 12AX7 family.

Those values of output impedance don't give excessive problems if we intend to drive only a few inches of cable and the grid of a following voltage amplifier stage. Things change completely in a preamplifier which is included in a separate chassis.

First of all, a coaxial cable is anything but an easy load whether it is 3 or 12 feet long. Secondly, with a separate low-level amplifier, we are not designing a closed system. We cannot know in advance what will be the input impedance of the power amp(s) we have to drive.

In order to drive heavy loads, we will need a very low output impedance—say 200-300 ohms. By "heavy loads," we mean solid state amps, input transformer amps (whose typical input impedance is 600 ohms), or a parallel of several tube amplifiers in a multiamplification system.

The above mentioned triodes do not suit our requirements for low output impedance unless we use more than one stage and add plenty of negative feedback. Since we systematically avoid any kind of negative feedback, including cathode followers, we have two remaining possibilities.

We can either use low plate resistance power triodes (6AS7 family) which are intended for series regulation (usually do not sound so good) or transformer coupled medium μ signal triodes.

The transformer solution is the one we chose to pursue. An output transformer would give us the low output impedance we need while avoiding the use of a very critical coupling capacitor in the signal path.

A further benefit is given by the enormously lower DC resistance of the plate load which avoids the waste of a big quantity of energy. For example, the voltage drop in the primary winding of our output transformer with its typical DC resistance of about 100 ohms is only 2 volts at 20 mA, while a 4700 ohm load resistor will give a drop of 94 volts at 20 mA. That means that we need to build a power supply capable of only 162 volts—instead of 254 volts—in order to get 160 volts at the plate.

But the most important advantage is the greatly improved plate circuit efficiency. This is the ratio of the audio frequency power output to the DC plate dissipation (power input). To better understand this let's see what would change in our preamp using the two different topologies.

We tried different versions of our circuit having fine results either using 5842-417A or 3A167M-CV5112 triodes. We will discuss the differences between the two types later; now let's examine what happens using a 5842-417A.

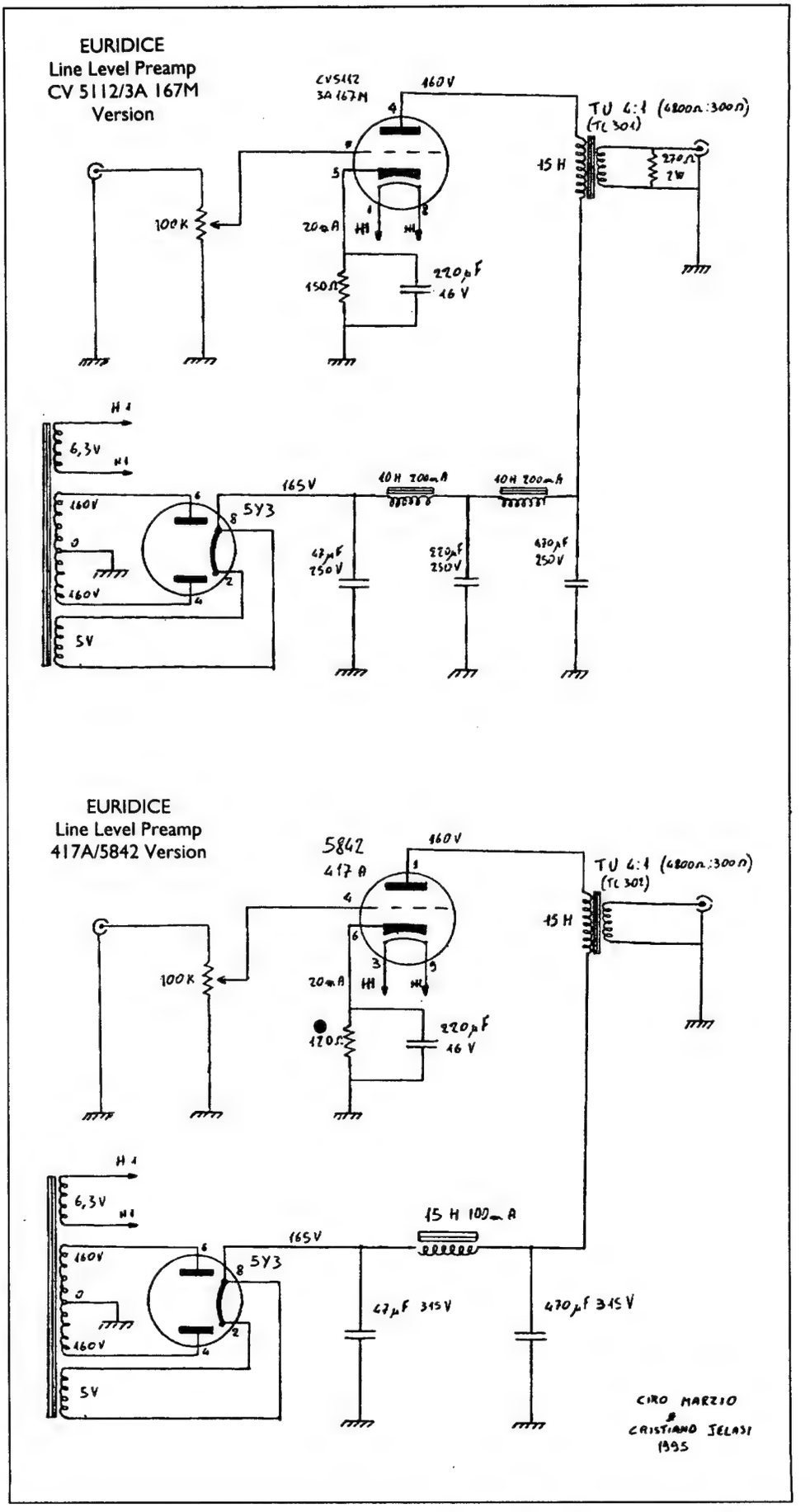
This 417A has a μ of 43, high transconductance (24,000 μmhos) and low RP, thus is suitable for transformer coupling. We chose to run it at 160 Volt 20mA for a plate dissipation of 3.2 watts, plate load 4700 ohms; under these conditions the power output is about 660 mW. We will not consider the interconnect cable influence in order to simplify things.

The real load seen by an RC coupled output device (5842) corresponds to the result of the parallel combination of plate resistor (4.7 kohm) with the following stage input resistor, ordinarily several times higher than the plate resistor. Let us consider a value of 47 kohm. The RC coupled stage will therefore work on a load of 4272 ohms which is still acceptable. However, the effective power available on the input will be very low.

In fact 10/11ths of the audio output power (600 mW) will be wasted on the 4700 ohm plate resistor while only 1/11th (60 mW) will be available on the input resistor (47 kohms) which is the load we actually intend to drive. Therefore the plate circuit efficiency will correspond to 60/3200 thus 1.875%. Isn't that terrible?

Let's see what happens in a transformer coupled circuit. In this case the plate load will correspond to the load applied to the secondary winding of the transformer multiplied the by the square of the transformation ratio. The power available on the load (input resistor) will correspond to that available on the plate circuit less transformer losses which will typically be less than 10% even if you use a very simple transformer design; thus 90% or more of the power (600 mW) will be available to drive our load.

Consequently, the plate circuit efficiency equals 600/3200 or 18.75%. This is ten times higher than in a usual RC coupled stage! Furthermore we can easily match our



output stage to the load by varying the value of the resistor that terminates the secondary of the transformer.

The trouble with output transformers —every rose has its thorns—resides in the design difficulties of such devices, not to mention high costs. The transformer should perform musically better than a capacitor of the same price range or else it's not worth it. This is not easy when the secondary of the transformer has many windings (as for a 4700 ohms/220 ohms device) because of the well known problems due to stray capacitance between primary and secondary winding.

A very good design is required as well as expensive and hard to find high permeability cores. Several conversations with the famous K. Imai of Audio Tekne helped us choose the right coils ratio and to solve some of the problems related with the design and construction of our transformers. We designed two different types of output transformers that have been produced for us by Megahertz of Naples, Italy. Contact info is provided below in case you don't want to wind your own.

The smaller one *TL301* features a MO core (75mm x 62.5mm x 40mm) with a standard 0.35mm lamination; 14 sections winding; turns ratio is 4:1 and primary inductance is 10H. They are pretty big since they can deal with 30 mA of DC current.

The bigger *TU1001* was designed also to be used to drive high impedance loudspeakers and features a beefy MO core (96mm x 80mm x 50mm) with a very thin (0.1mm) lamination; 18 sections winding; turn ratio is 4.4:1 and primary inductance is 20H. It can handle up to 80 mA of DC current; this means that if you like you can design your own preamp around a 300B or a VV30B. This output transformer performs superbly even if it may seem somewhat expensive.

Using a TL 301 or a TL 302 in conjunction with a 5842 triode, the overall gain of our circuit is about 8 with a maximum output of 14 Volts RMS on a 300 ohm load. Enough to drive any power amp we know.

In essence, the circuit is very simple. It is basically an output stage of a classic single ended amp. That means that all passive components must be of excellent quality. We used paper in oil caps and A-B resistors in our version.

The volume control could be a series stepped attenuator or even better a ladder attenuator. You can find detailed instructions on the construction of such a device in the Welborne Labs Catalog (ph. 303-470-6585; fax 303-791-7856). We used Holco resistors and Grayhill switches in ours. This solution costs something more than a good film potentiometer but performs way better.

Among 417A type tubes, Raytheon 5842 and Western Electric 417A gave us best results. If you go for WE 417A, watch out for microphonic specimens. 3A167M/CV5112 is even a better choice. This monster tube which has a plate dissipation of 12 watts even less than that of a 6J5, features an unbelievably high transconductance of 47000 μmhos, a μ-factor of 47 and an internal impedance of only 1000 ohms. Unfortunately this triode, manufactured by ITT and STC, is very scarce even in Europe. Be aware of the fact that many of those tubes are microphonic.

The power supply uses a 5Y3 valve followed by a classic capacitor input π filter. In order to preserve the rectifier tube we used a rather small filter input capacitor to limit inrush charging currents at turn-on. On the ouput of the filter we used a large capacitor to lower the internal impedance of the power supply in order to enhance bass and mid-bass performance. We used custom made polypropylene caps bypassed with paper-oil capacitors.

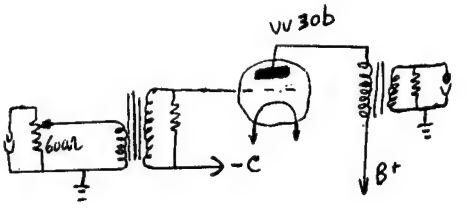
We are quite satisfied with the sound of this preamp. Music has great impact, a rich harmonic presentation and a flawless dynamic range. Even if you use the small TL 301 output transformer and 5842-417A triode you will enjoy music in a way that is more 'alive', less 'reproduced' than with any conventional hi end design.

We think that this preamp—although a very simple basic design—is a step beyond conventional preamps, but if you want more you may improve power supply filter realization by adding further LC cells and using high quality paper in oil caps.

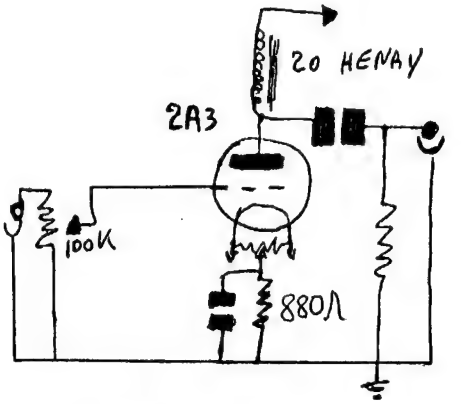
The way *Euridice* gives energy to the music is really impressive: even the lower level details come to your ears without any apparent effort. To go back to your Audio Note, Conrad Johnson, Convergent Technology, etc. could be shocking: the sound will seem dull, lifeless and unexpressive.

Other Directions

If you want to go even further you may try to use DHT. We have tried—with fine results—single plate 2A3, 45, 71A, VT52, and VV30 using a high quality super-permalloy core step up input transformer to obtain the gain we needed. Of course there are many other DHT well suited to this use, many paths of experimentation to pursue.



Transformer-coupled line amp 1:4 step up transformer, VV30B



Choke loaded preamp

Good Italian Reading

This circuit originally appeared in the 1/1996 issue of the Italian language *Costruire HiFi*, one of the world's leading DIY journals.

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More transformer-coupled action from the Boot of Italy

Everything began when a customer asked me to build a competent line level preamp to drive his Audio Note P3 power amp.

When someone asks me to build something, especially if it's apparently simple (and what in the world is more apparently simple and inherently tricky than a line preamp?), and the budget is not too strict I think there is really no point in giving him a product that may be similar to anything commercially available. A custom product must be real special and, from my standpoint, this is how this preamp had to be — special.

Besides, in that period I was working on the development of a pair of "reference" quality, 300B based parallel single ended monoblocks and I wanted to design a dedicated preamp to partner them. My customer willingly offered himself as a guinea pig for this experimentation! This set of circumstances is where the WOT project originated.

Why a Line Preamp?

A while after CD started gradually replacing the LP as the main audio source of the "average" listener, a previously nonexistent item was invented, the line-level-only preamplifier. Most of its claim to fame in my opinion are business considerations rather than strictly technical ones. After getting away from the most "preampish" part of the preamp, the phono stage, the audio industry, and especially the smaller companies manufacturing high-end gear could not afford not to sell preamps anymore.

I'm saying this because, in a merely technical view, i.e. from the standpoint of impedance matching, gain/distortion distribution characteristics and dynamic behavior, it is my opinion that a line-level-only system is much more sensibly (and "better soundingly") built around an appropriately designed integrated amplifier.

The only limitation to this is when there is more than one power amplifier. This is just a general consideration which applies to several situations, spanning from the simplest case of a monoblock pair to the sophisticated electronic-crossovered multiamping possibility.

All of the above configurations have one thing in common: if sensibly implemented, they're NOT to be met in cheap systems (before anybody starts to doubt: exceptions like bi-ampings with four bridge-connected $300 NADs are NOT classified as sensible in this article).

The above talk sets an initial quality target to justify the effort: an accordingly sensible line preamp, and this time by "sensible" I'm meaning "competent with the above", shall NOT be designed or built on a budget, since mediocre quality would rob it of any meaningfulness.

At the risk of repeating myself, cheap line preamps are complete rubbish, conceptually more than qualitatively, because they're useless. If you are on a budget and only listen to CD you don't have to hunt for a preamp at all. Get or build yourself a proper integrated instead, and you will live happily. And please, don't waste money trying to multiamp with crap amplifiers. A single good amp is ALWAYS better than a row of tin boxes, for the same price.

How a Line Preamp?

After deciding our line preamp is meant to be "good", what do we want it to do then? First of all, we want it to put out POWER to grip the input of our power amps and not let go, then we want DYNAMICS because it's a preamp not a DBX broadcast compressor and, in order to get these dynamics, we need LINEARITY which also makes for LOW DISTORTION. We don't want too much GAIN simply because we don't need it. These are the clear and simple priorities to start with.

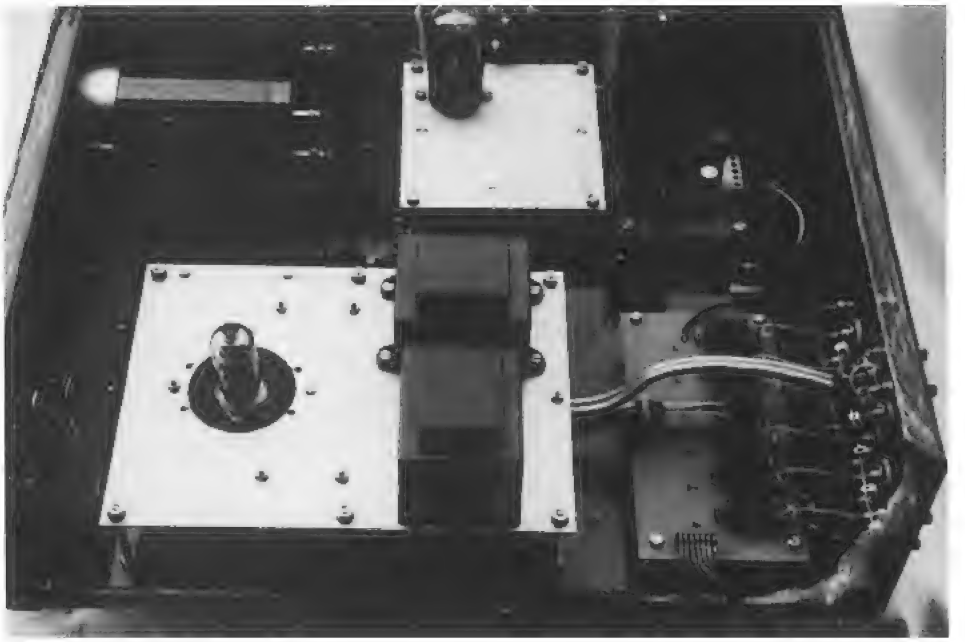
It is quite possible to design a preamp fulfilling the above requirements with a single stage and no feedback but, after doing that, it is important to transfer the signal so linearly modulated by the circuit to the load (the power amps) as efficiently as possible. And a transformer is by far the most efficient device for this purpose. You can use many other circuits obtaining good efficiency by electronic means (SRPP, Mu Follower) and still get a completely respectable and satisfactory machine, but believe me, there's really no comparison with transformer coupling when it is working properly.

Circuit Choices

It is quite obvious that the most suitable active device for this project is a triode. An appropriate triode for this preamp must have very definite characteristics:

First of all, it has to be a high transconductance medium "μ" type because the overall gain required is quite low and it must be obtained without feedback; at the same time the input level could also be extremely low: at low volume the grid drive is barely microvolts and the tube must be extremely responsive even at these levels in order not to lose resolution under such conditions. Besides, modest "μ" and high transconductance make for low plate resistance which limits the primary inductance demands on the output transformer.

Secondly, this triode has to be extremely linear and capable of working at relatively high plate voltage with good plate dissipation, to get vast dynamic leeway and work well under maximum output conditions. This makes for very low distortion and relaxed, accurate and unconstricted reproduction of contrasts and timbres.



Layout showing suspension-mounting arrangement for 5687

Power triodes are unsuitable for this purpose since they are not at their best working at microvolt levels: they show excessive input capacitance, are too microphonic, too low in amplification factor although good in plate resistance, and shutting heater noise up is a pain in the ass. I mean, no 2A3 preamps. 2A3 is extremely good for the application it was originally meant for, but not this one. Sorry.

Careful consideration of all sensible triodes available to me showed the best compromise overall to be the 5687. It sports a tough plate dissipation rating, reasonable μ, very high transconductance, it is so linear it can modulate 150 Vpp even when biased with less than one milliamp, and is not very microphonic.

The 5687 is superior to the 6922 in linearity and low signal level performance, can stand much higher plate voltages than the 5842, has lower plate resistance than the 6SN7 and is not terribly expensive.

5687s have two bad characteristics, however, that require care in design: one, they tend to draw some grid current and, two, they always leak a bit between cathode and heater. Luckily, both negative effects can be neutralized with shrewd design strategies so they are not insurmountable problems.

The output transformers are custom and have been specified after setting a range of possible loads at output and assuring optimum dynamics from open-circuit down to 5 kohm. This preamp will work correctly into virtually any possible power amp load, although its gain will obviously decrease with increasing load. That is, lower power amp input impedance will mean lower chain sensitivity at preamp input.

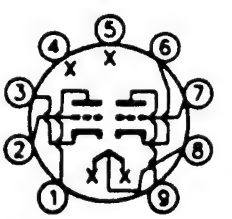
This unit is NOT designed for particularly low output impedance but rather for best power transfer and dynamics; therefore it must not be loaded with excessively capacitive loads, otherwise the slew rate will suffer. This is no serious limitation provided you don't use silly cables or big bad transistor acoustic polluting machines.

Otherwise the circuit is extremely simple. Either section of the tube takes care of one channel and is biased with a bypassed resistor. The grids are directly coupled to the wipers of a precision ganged pot which in turn is directly coupled to the input selector. The pot with its short leads is sufficiently insensitive to 5687 grid current not to give trouble. The output is unbalanced and grounded to chassis in such a way as to make the preamp non-inverting, but the output transformer secondaries do have center taps so that a balanced XLR output is obtainable if desired.

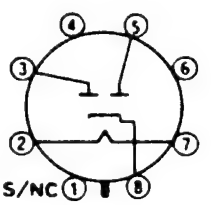
Attempts to obtain a floating output (grounded at power amp side only) caused such big troubles to consider this option totally out of the question.

WOT parts you need

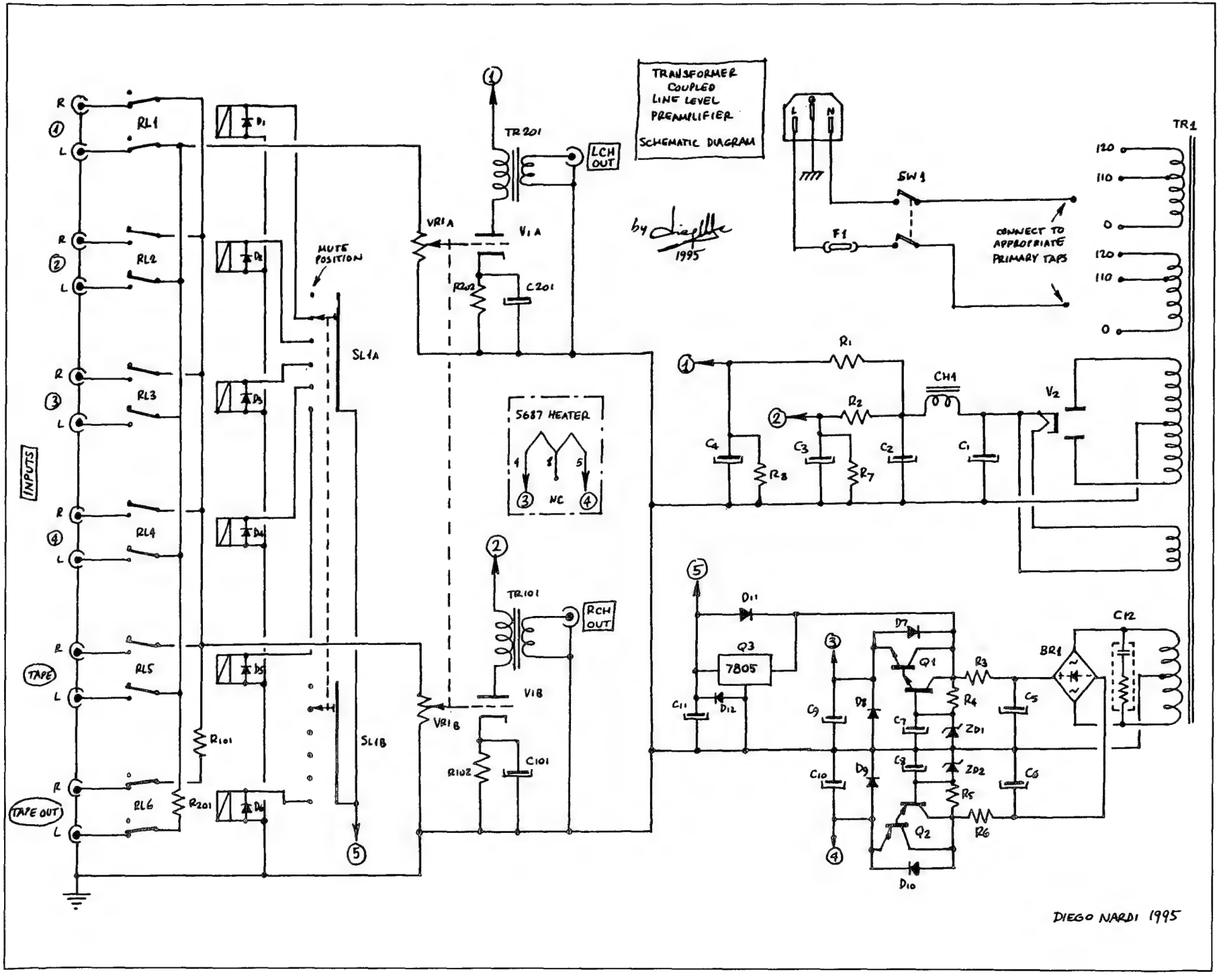
R1, R2	5k6/5W	ceramic wire wound
R3, R6	1R/2W	wire wound
R4, R5	68R/1W	carbon film
R7, R8	270k/1W	carbon film
R101, R201	22k/1/4W	metal film
R102, R202	390R/1/4W	metal film
VR1	100k B taper	volume potentiometer
C1	47µF/450V	electrolytic
C2	150µF/400V	electrolytic
C3, C4	1800µF/400V	electrolytic
C5, C6	10,000µF/35V	electrolytic
C7-C11	470µF/16V	special low ESR electrolytic, Rubycon PS1/PS2
C101, C201	220µF/16V	Rubycon Black Gate standard type
BR1	80V/3A	bridge rectifier
D1-D12	1N4004	
ZD1, ZD2	7V5/1.3W	BZX85 series zener diode
Q1	BDW 93	
Q2	BDW 94	
Q3	L7805CV	
C12	.1µF+47ohm	class Y surge suppressor
SL1	2way/6 position rotary selector	
SW1	DPST power switch, 250V/4A	
RL1-RL6	DPDT 2A miniature sealed relay, 5VDC coil, Omron type G5V-2	
TR1	Power transformer, 2x 0-110-120V primary, 230-0-230V @ 60mA, 6.3V @ 0.6A, 9.7-0-9.7V @ 1.2A	
TR101, TR102	Proprietary output transformer—available from the author $330/pair, airmail included	
CH1	70H @ 40mA choke, DCR = 1.5kohm	
V1	5687	
V2	6X5GT	



5687 Base diagram



6X5 Base diagram


TRANSFORMER COUPLED LINE LEVEL PREAMPLIFIER
SCHEMATIC DIAGRAM
by
1995
INPUTS
RL1
RL2
RL3
RL4
RL5
RL6
TAPE
TAPE OUT
MUTE POSITION
SL1A
SL1B
TR201
TR101
LCH OUT
RCH OUT
VR1A
VR1B
5687 HEATER
NC
7805
SW1
F1
CONNECT TO APPROPRIATE PRIMARY TAPS
TR1
120
110
0
CH1
BR1
DIEGO NARDI 1995

The input selector is implemented with a bank of relays having a common coil ground and separate positive rails being operated in turn by the rotary selector on the front panel. One of these relays disconnects the tape output when the "tape" input is selected so the risk of tape loops is eliminated while doing away with the need of a tape monitor facility and therefore simplifying the signal path.

The Power Supply

A power supply for a preamp poses problems that are substantially different from those encountered in power amplifiers. The HT supply for a Class A power amp, and especially for its output stage, has to deal with a circuit modulating a large percentage of supply voltage and current if the amp is single ended (the problem is not so severe with Class A push-pull but is very similar and even worse in Class AB). Therefore it is necessary to design a fast and nimble supply with short recovery times, rather than one that stores a lot of energy.

High energy storage, to be of advantage in a power amp, would have to be SO high to be really unpractical. Trying to store "medium-high" amounts of energy would only end up in using slower components without really being of help.

This preamp, and preamps in general, if correctly designed will modulate only modest percentages of the available supply power, because it can be dimensioned for so much dynamic headroom that only a small part of the maximum possible modulation will be actually exploited in normal use. (Big dynamic leeway was one of the design priorities, do you remember?). Therefore it becomes feasible and, in my opinion, convenient to store so much energy in the power supply that the latter will virtually see no difference among the various no-signal, steady signal and transient operating conditions that the preamp is likely to handle during actual use. This is the direction I took.

The schematics of the supply are rather conventional: the rectifier is a 6X5GT indirectly heated twin diode, octal equivalent of 6X4, used in "direct-heating" configuration, i.e. with one end of the heater strapped to the cathode (in this way no use is made of the tube's cathode to heater insulation, thus eliminating the headaches potentially caused in time by cathode to heater leakage, a relatively frequent trouble in these tubes).

What is not conventional is the way the filter was calculated. The first filtering stage is PI-configured, with capacitor input. I preferred this to the choke input due to the better ripple rejection obtainable with a single choke (OK, this preamp was NOT made on an extremely limited budget but nonetheless costs and size had to be reasonable!) and to its higher rectification efficiency. As I always do, however, I took peak current and inverse voltage diode operation characteristics into extremely careful consideration, in order to assure the longest rectifier life.

The choke and the second capacitor are sized to push the resonant frequency of the filter as low as possible, far, far lower than ripple frequency and virtually out of the preamp's bandwidth, in order to get substantially constant output impedance across the whole reproduced low end, even without decoupling.

This filter provides an extremely smooth and soft energy source, even though still at a relatively high impedance compared with regulated supplies. It is intended to operate as a sort of "battery charger" for the following decoupling stage. This is made out of a 5k6/5W resistor and a 1800μF/400V electrolytic cap per channel, for a time constant of about ten seconds.

These capacitors, during bench tests, display constant (and very low) ESR. up to about 50 kHz and are in fact acting as batteries in the general economy of the preamp. In fact, assuming the charged cap to be disconnected from the rest of the filter, the time constant of the filter cap and the dynamic resistance of the preamp circuit is on the order of 30 seconds while the internal resistance of the capacitor at frequencies of our interest is in the order of fractions of an ohm. Given that the average duration of a musical transient is measured in milliseconds, all of this combined makes for superb transient regulation which was precisely my goal.

Experiments in bypassing these capacitors provided horrible high-frequency colorations, confirming once again what I've long been convinced of, i.e. bypassing electrolytics is basically playing around with audiophile bullshit coloration mumbo-jumbo, and *not* an effective way of improving sound. You might in fact find it amusing that ALL of the (not many) caps used in this preamp are unbypassed electrolytics!

The heater supply, as previously noted, required some care due to the 5687's tendency to leak slightly between cathode and heater. A solution that appeared to work fine consisted in a dual symmetrical power supply, with grounded common, lighting up the heater of the tube at 12.6 V while keeping the two extremes of the heater at basically the same impedance to ground.

Indeed, this is still a compromise because in fact the two heater elements are connected in series within the tube so that the one heating one section is powered by the positive rail and the other by the negative one. This means that cathode to heater voltage is different in the two sections, but filter time constant and regulator operation considerations made this solution appear as the most convenient overall.

The heater voltage is regulated with complementary Darlington transistors in a conventional series arrangement with no feedback. The positive heater rail also powers a 7805 IC used for relay coil operation.

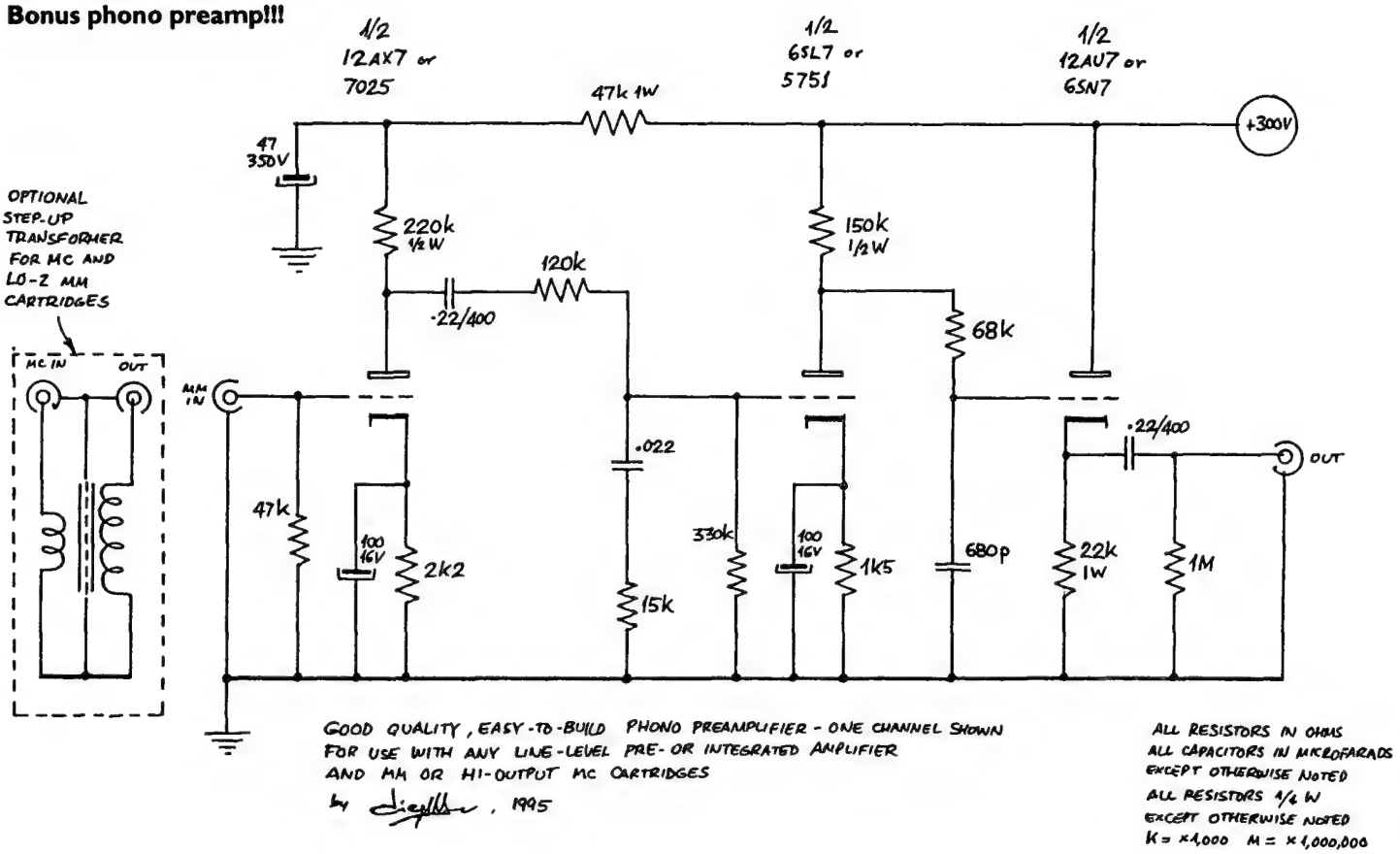
Construction Tips

It is of great interest to try and limit microphony as much as possible. Any effort made in this direction will pay more than worthwhile dividends in quiet operation and sound quality.

Since builders will opt for their own mechanical solutions, it is largely up to you how to face this problem, however here's my suggestion. Instead of rigidly bolting the socket to a hole in the chassis as is normal practice, drill a hole in the circuit plate or chassis about three times the diameter of your socket and suspend the socket on tension springs (they will have to be quite stiff), then connect socket pins with flexible wires. Refer to pictures, they are clearer than any explanation. This type of mounting is surely not an effective space-saving measure but, for your joy and delight, here you only have one tube in the circuit!

The output transformers as supplied are unshielded and like all low level transformers, are prone to picking up hum quite easily. It is necessary to find an orientation that yields minimum hum pickup before securing to the chassis. The arrangement you can see on the pictures is nice looking but admittedly not optimal in this respect. As an alternative, you could also make a steel cover to protect them when they're within the preamp. Shielding these transformers at the factory was awkward for mechanical reasons given the chosen core size, so I decided to take care of isolation in the layout.

Bonus phono preamp!!!



My prototype uses Black Gate cathode bypass capacitors, value 220µF/16V, and is wired inside with Audio Note AN-V interconnect. Unlike other products, this preamp is extremely sensitive to the quality of internal wiring and it is definitely worthwhile to use high-quality interconnections within. It is not terribly expensive to provide this design with high-quality components, as they are really few in number.

Apart maybe from some form of output transformer enclosure, I recommend the chassis be made of non-magnetic material, i.e. aluminum or copper. For my prototype, the bottom was a surplus Audio Note OTO chassis and the top and internal plates were custom built out of 1.2 mm thick aluminum. All screws are brass.

WOT Applications

This preamp is dedicated to whoever wishes an extremely high quality line preamp for whatever system, best if based on high-quality triode amplifiers which will exploit its potential to the fullest. It will blatantly outperform anything you may find at your local high-end store up to many times its cost.

Bass quality, dynamic progression and absolute lack of "electronic distortion" are its main strengths. It is actually more at its ease in reproducing music from analogue records through a very good phono preamp than with CD, provided there is proper electrical matching with the phono preamp output. CD is reproduced without strain but CD quality is clearly audible through it and is quite uncomplimentary to its transparency.

DACs having IC current to voltage conversion and/or IC output stages will come out in all their artificiality regardless of what they claim about their jitter performance.

Free Phono Schematic!!!

If you want to quickly check out the line amplifier, given above is an easy and simple phono stage I originally developed as a modification on an old C-J PV2. You can either build from scratch or on the PCB of your C-J, ARC, Jadis, Audible Illusions or anything with 3 tube sockets on it. A true phono unit for use with the WOT I will design when I have time! Try this combination out in the meantime.

Diego Nardi
via Volterra, 12
20146 Milano MI
ITALY

one electron™
Single-Ended Output Transformers
High Quality for a Reasonable Price
Designed and Built in the USA



4.8k primary
15 watts
160 mA
$118
Can be used with:
300B, 50, SV811-3, etc.

Also Available

UBT-1
Designed for parallel operation of:
1.6k primary
15 watts
110 mA
$95
2A3s, EL34s, 300Bs 6AS7s, etc. or Sweep-tube in "enhanced triode" mode

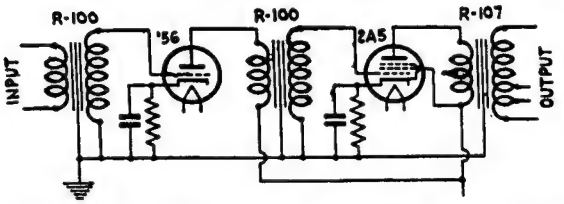
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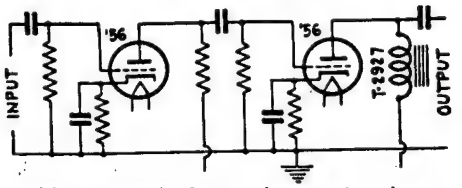
Audio Systems

CIRCUIT A



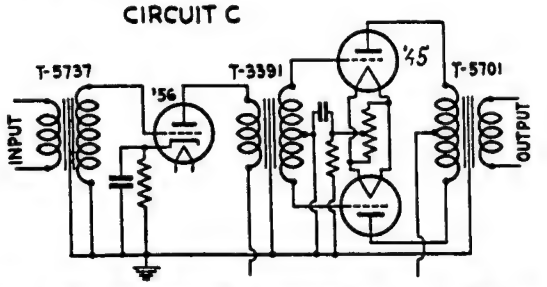
A good, straight, audio amplifier circuit. The center tap of the R-107 transformer is ignored in this circuit. From 45 to 55 Db. gain may be secured from this circuit with 3 to 4 watts power output. Fair quality.

CIRCUIT B



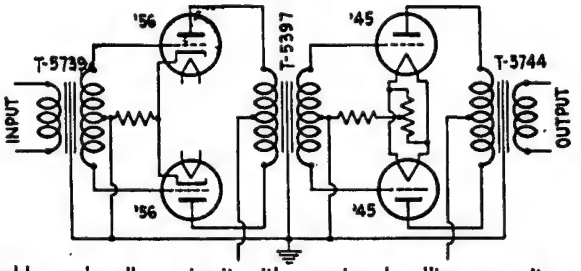
Voltage amplifier, primarily for condenser microphone or one of the newer crystal, ribbon, or dynamic microphones preceding a power amplifier. Brings signal level up about 25 to 28 Db. Good quality.

CIRCUIT C



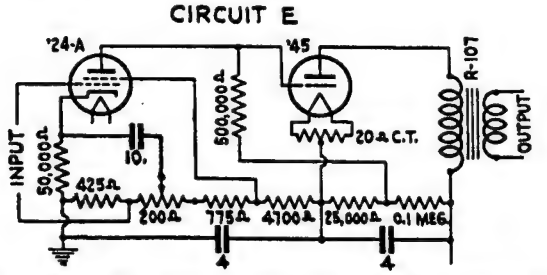
Straight audio into push-pull. Improved by use of 56 and 45 tubes over original 27 and 71A tubes used in early radio sets. Secures 20 to 25 Db. gain with about 4 watts output. Tone quality excellent.

CIRCUIT D



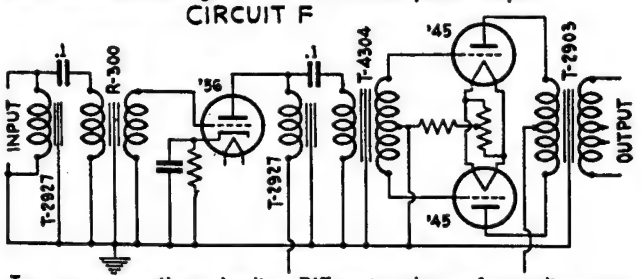
Double push-pull, a circuit with amazing handling capacity and freedom from distortion. Probably the best low power circuit in use. About 25 Db. gain with 4 to 5 watts power output.

CIRCUIT E



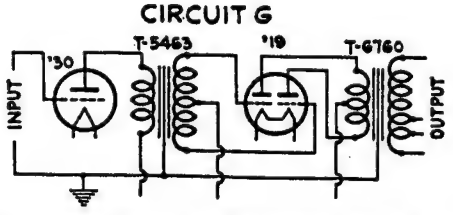
Basic Loftin-White direct coupled amplifier. Resistance values are rather critical and are given to assist servicemen in making repairs. About 45 Db. gain and good quality possible up to 3 watts.

CIRCUIT F



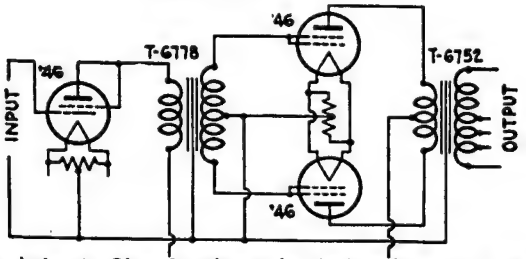
Tone compensating circuit. Different values of coupling condensers change frequency response. Primarily for use where bass notes must be overemphasized to compensate for a small speaker baffle. About 25 Db. gain.

CIRCUIT G



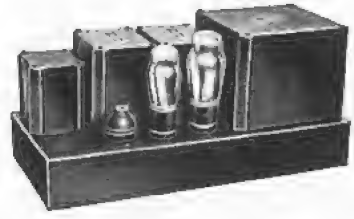
A battery operated Class B amplifier widely used in two-volt rural sets. Will deliver 2 watts with heavy duty B batteries as power supply. About 40 Db. gain with good quality on full volume.

CIRCUIT H

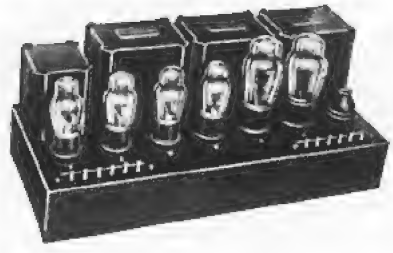


Good design in Class B utilizing the dual grid 46 tubes, first as a triode-driver and in push-push as a power output. Will deliver 20 watts if supplied from a good power pack. Only about 22 Db. gain.

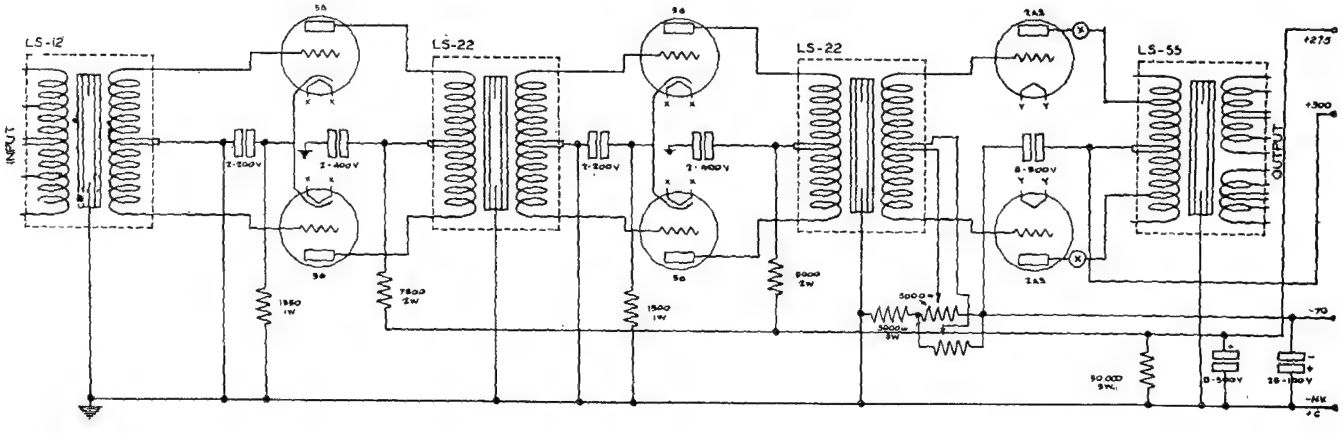
The triple push pull fixed bias 2A3 amplifier circuit shown below will satisfy the most discriminating Broadcast stations and audio laboratories. The undistorted class A output is 15 watts, the gain is 80 DB. The amplifier is uniform in response from 30 to 12,000 cycles. A trap reasonant rectifier filter is used for highest filtering efficiency, audio and power sections are mounted on separate drilled, heavy gauge metal decks. All LS audio filter and power components fully shielded and doubly sealed against adverse climatic conditions. List price of complete transformer kit $152.50 [includes drilled decks and perforated protective covers—all transformers mounted at factory at no extra cost] 40% discount or net price of $91.50 to Universities, Broadcast Stations or dealers. Purchase through your local U.T.C. distributor.

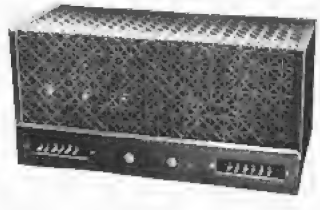


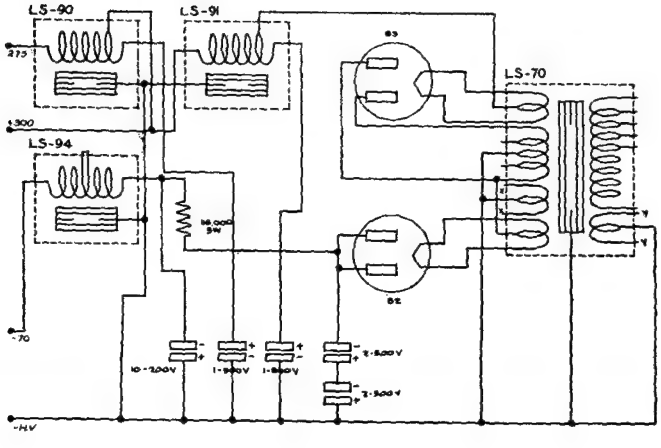
2A3 Power Supply

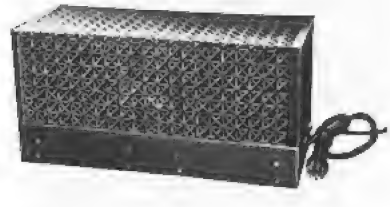


2A3 Audio Amplifier









2A3 amplifier and power supply with perforated protective covers fully mounted.

MAUHORN



by Andreas Mau
Lowther Club Deutschland
World's greatest Lowther fan

My *Type IV* 3.5m horn uses 22mm boards for the outer case with the following dimensions:

2 each 102.5 cm x 82.5 cm
2 each 25.6 cm x 82.5 cm
1 each 25.6 cm x 98.1 cm

The best way to put the enclosures together is to place a large side panel on the floor or table and glue the parts of the horn onto it. The final step is to glue the other side panel on like a cover.

Lowther for Life!

The beginning of it all for me was a demonstration of the Lowther Classic 400 by a friend of mine. I was surprised how clear and natural the sound was. I built the *Acousta 124* and the *Delphic 500*. I thought the very best solution would be a one drive unit direct-radiator with a large bass horn.

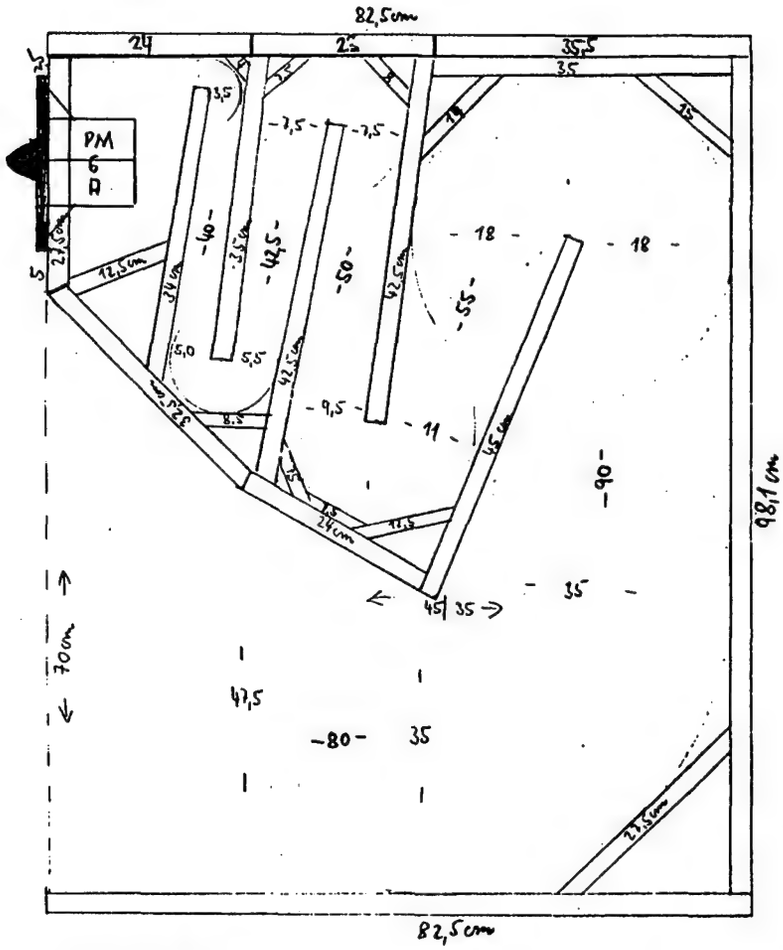
I tried the old *Acousta 115* but the wood in the panels was too thin. The wood for a bass horn must have 19mm strength. The sound of the *Acousta 115* with a PM6A was fine and very clear but the bass was very thin. So I planned a larger bass horn with a little magnet chamber.

I did my research on these cabinets in 1985 and 1986 and published the results in the German loudspeaker journal *Klang & Ton* in November 1991.

My first horn with a 3.5m length was fitted with a PM7A driver. I was totally blown away with the dynamic bass response. Live sound! I closed my eyes and I was absolutely delighted. Such a clear sound I never heard before. I was a speaker builder for many years and I tested many constructions, including big transmission line cabinets fitted with KEF and Celestion drivers. They all sounded poor and unnatural compared with Lowthers on a long bass horn.

Both of my cabinets feature a small magnet chamber. One horn is 3.5m long and one is 4.5m long. Both are 25.6cm wide inside width. I used 22mm shipping boards for the outer walls of the cabinet so the outside width of the cabinet is 30cm. A combination of 19mm and 16mm boards were used for the reflectors.

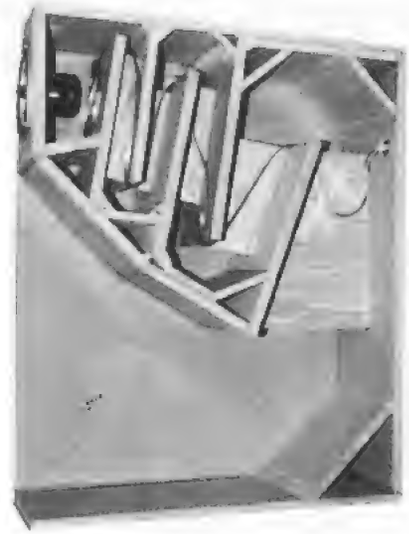




MAUHORN Type IV

Outside Dimensions
Depth = 82.5 cm
Height = 102.5 cm
Width = 30 cm (26 cm inside)

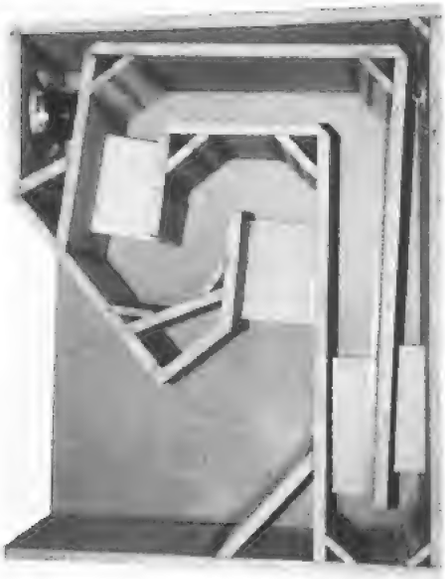
Volume = 254 liters
Bass horn length = 3.5 m

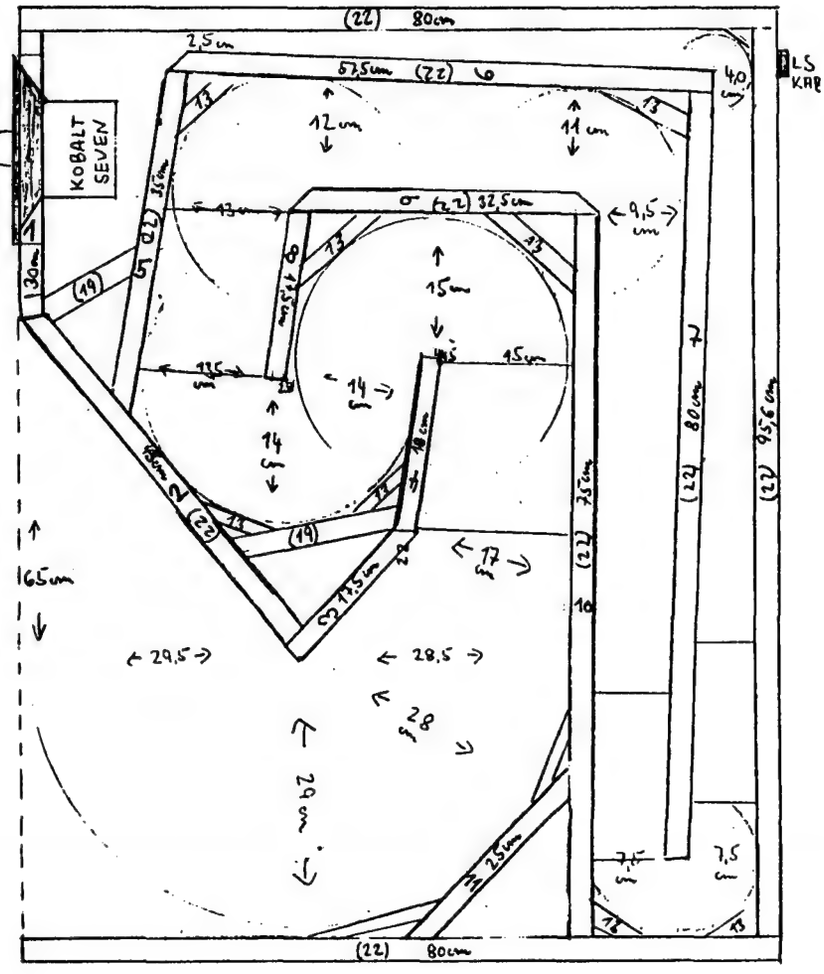


MAUHORN Type V

Outside Dimensions
Depth = 80 cm
Height = 100 cm
Width = 30 cm (26 cm inside)

Volume = 240 liters
Bass horn length = 4.5 m





After I built the outer cabinet I installed an extra 22mm panel on each side for reinforcement. So now each cabinet weighs 80 kg and requires 6 rollers!

I initially designed these cabinets for myself, so the sketches provided below are the only drawings I have.

This cabinet is relatively small and it can be located near the side walls in the corners of the room. The cabinet can also be mounted on a wooden frame with the driver and horn mouth facing down, for use as a subwoofer. Another idea is to position the cabinets with the drivers facing the rear wall and then use a forward-facing small cabinet or midrange horn for the high frequencies.

The *Type IV* 3.5m horn is intended for use with the PM7A, 2A, and 5A drivers. The *Type V* 4.5 m horn is for PM6A and 7A drivers because of the little back chamber. I designed these cabinets as modules, thinking that more cabinets can be put together if I ever wanted to move more air.

The sound quality of both horns is fantastic. The shorter horn offers a more pressurized, high energy bass response while the longer horn sounds more inconspicuous, but extremely clear and with deeper bass extension. Standing in the corner, the wall serves to enlarge the mouth of the bass horn.

The large panels on the horn should definitely be stabilized by additional panels. There is no need for any damping material such as wool, coatings, or anything else. Note that the chamber is very small and the pressure inside is very high. I think it is a high-performance racing motor of a sports car, an old design driver in a high-pressure cabinet! This is what I did not find before in any of the factory *Acousta* and *Bicor* cabinets. To reproduce 40 Hz bass the cabinet must have a certain size. The large bass horn is the best solution. You will only need a 2 or 3 watts per channel amplifier to play music in natural live atmosphere sound.

As Paul Voigt was a son of German parents, I feel that I have to work for his name. Why do so few people know of Lowther and Voigt? As so many people are now interested in Lowther there is no need for more words. You will see what happens when great loudspeaker fans hear Lowthers for the first time. They will throw all other speakers out of the window!

The top-end Lowther cabinets are the great corner horns like the *Voigt Domestic Horns*, *TP-1*, and *Opus 1*, but if you are looking for a mid-size, easy to build construction, please hear my horns. Never will you forget!

Andreas Mau
Lowther Club Deutschland
Postfach 12 46
24584 Nortorf
Germany
FAX 0049/4392/ 8168

BUILDING THE MAUHORN TYPE IV

by
Jérôme Phaneuf
Experiences Sonores

The story began when my father read the articles by Haden Boardman and Joe Roberts about Lowther in *SP*. He was impressed that they were so enthusiastic and he soon wanted to know more about the product. He called Frank Reps, a longtime votary of Lowther and after the long praises of Lowther Frank sang to him, he began to look at his *3A Master Controls* differently. Mr. Reps was apparently living an audio experience that my Dad couldn't even think possible. He sent the plan for the *Acousta* to my Dad: "Try them Christian!" Dad had a pair made by one of his friends and the reign of the 3As began to fade.

Then he wrote to Andreas Mau to ask for plans of another good Lowther enclosure. Dad wanted something simple to build, like the late model *Acousta*, since we don't have a lot of woodworking tools. Mr. Mau kindly sent him the plan of the *Fidelio* along with comments and pictures of different types of Lowther enclosures. But there was something else in the envelope. . .

It was the plan of a tremendously long horn (3.5m), featuring a very narrow baffle and a small driver chamber. The box itself is about 83 cm deep, 1 m high, and exactly 25.6 cm wide inside the horn. A big enclosure but since it is very narrow, it can fit in a medium-sized listening room quite well. Be sure that the floor is strong enough to hold them, because each of these superboxes weighs over 100 pounds! Dad was intrigued by the idea of a very long horn in a not-so-big box. And, after all, since Mr. Mau sent the plan, it was certainly a product of that world-renowned German engineering. "Son, can you build that?"

We decided to use 3/4 thick Russian veneer which is made of 15 layers of white, good smelling, and very dense birch wood. This plywood is the best quality available here. I suppose we could have used MDF, but Dad is a no-compromise kind of guy and I hate to work with MDF. It is always crumbling. Have you ever seen a violin made of MDF? Anyway. . .

The plan was a little hard to follow since my German is not very good. The major challenge was to adapt the plan so I could use plywood of the same thickness throughout the enclosure. Mr. Mau uses boards of different thicknesses in his horn so I had to recalculate to ensure that internal dimensions remained the same.

I filled all the cavities with insulating foam to avoid box resonances (when the box is closed, it's too late, pal!). I also ran the speaker cable (silver) in the upper panel of the enclosure because I was afraid it would vibrate when the music played if I ran it through the labyrinth. This measure also reduces the length of wire required, a good thing economically (for us garage sale cheapskates) and sonically.



Finally, following wise advice from Frank Reps, I made extra sure that all of the seams in the driver chamber were perfectly smooth. We carefully filled and sanded the edges all over the length of the horn. I'm not sure that this does any good but it can't hurt. In any event, Dad and I wanted to be sure that we maximized our efforts before the enclosure was sealed. Months of weekend work later, The Day Came.

We are not many, but we know how to find each other

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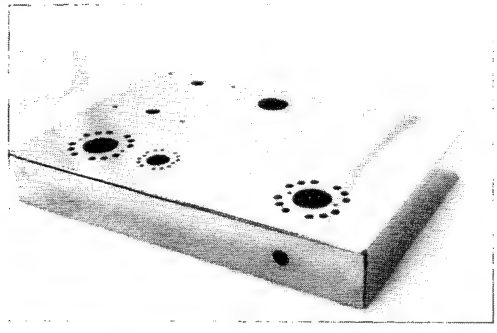
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I fitted those babies with my father's new pair of PM7A "Hi-Ferric" units. At this time, Dad was very anxious. He was choosing some CDs to make the test—Dave Grusin's *The Gershwin Connection*, MJQ and friends, some Sheffield (including Drum Test Record), etc. Oh god almighty! This was good sound! I never thought those delicate Lowther drivers could have so much bass. Clean, true, clear bass, I mean. Not that kind of fat, artificial boomy bass we hear so often. It was a good idea on the part of Mr. Mau to design the box very narrow. While improving imaging, this design make the horn stiffer so it won't vibrate a lot at low frequencies to make what I call the "box sound."

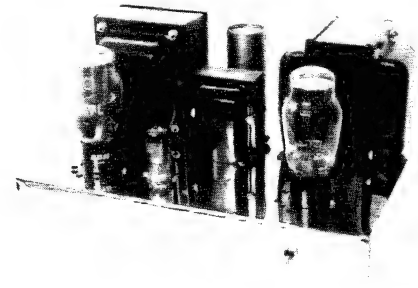
Before we listened to the **MAUHORN** or any Lowther at all, Dad's good friend Frank Reps told him that the Lowther experience was like removing heavy blankets that were hung in front of your speakers. I was a bit skeptical. How could a homemade enclosure sound better than the 3A Master Control driven by an excellent 300B amplifier? I have not heard thousands of speakers like you audio fanatics, but I've heard a certain number of very fine systems and nothing (according to my personal tastes, naturally) even approached the natural sound of the 3As.

I will tell you the truth—the 3A Master Control never played again in the house after we hooked up the **MAUHORN**. Frank was right: the blankets were removed and it was time to listen to some unmuffled music. The sound was so limpid, image so good, fine details we never noticed before began to appear—the illusion of being there with the musician was striking. The **MAUHORN** is indeed an excellent design that Andreas Mau must be proud of. Trust him! Make yourself a pair. You will have no regrets when you sell your other speakers to somebody else.





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Not your Father's DYNA. . . A Poor Man's SE Amp

by Dave McDonald and Matt Kamna

Dumpster diving Dyna fans take note!

How did I end up with a single-ended Dyna stereo 70? A little background will help to understand. As a kid I grew up with vacuum tubes—Knight Kit regenerative and superhet shortwave radios, 12W mono amplifiers, and later a Citation 30W integrated amp kit. There were solid state kits too, including an 80W stereo amp. I did a lot of tinkering in those early years, mostly making solid state radios, science projects, and the like.

A couple of years ago over at my friend Matt's house, I was exposed to SE WE212E amps flooding the room with light and sound. The 212E amps were too expensive for my budget. I also assisted in the creation of 2A3 and 300B amps. Listening proved that a low power amp could give that same wonderful sound.

I remember one Oregon Triode Society "DIY night" meeting where I got to hear many amps and speakers that were either modified or built from scratch. There were pentodes, triodes, tri-amp systems driving horns, etc. Those were exciting listening days!

I decided to pick up an inexpensive vacuum tube amp and start experimenting, so a Dyna ST-70 soon followed me home. Music listening was much more comfortable compared with my solid state amp.

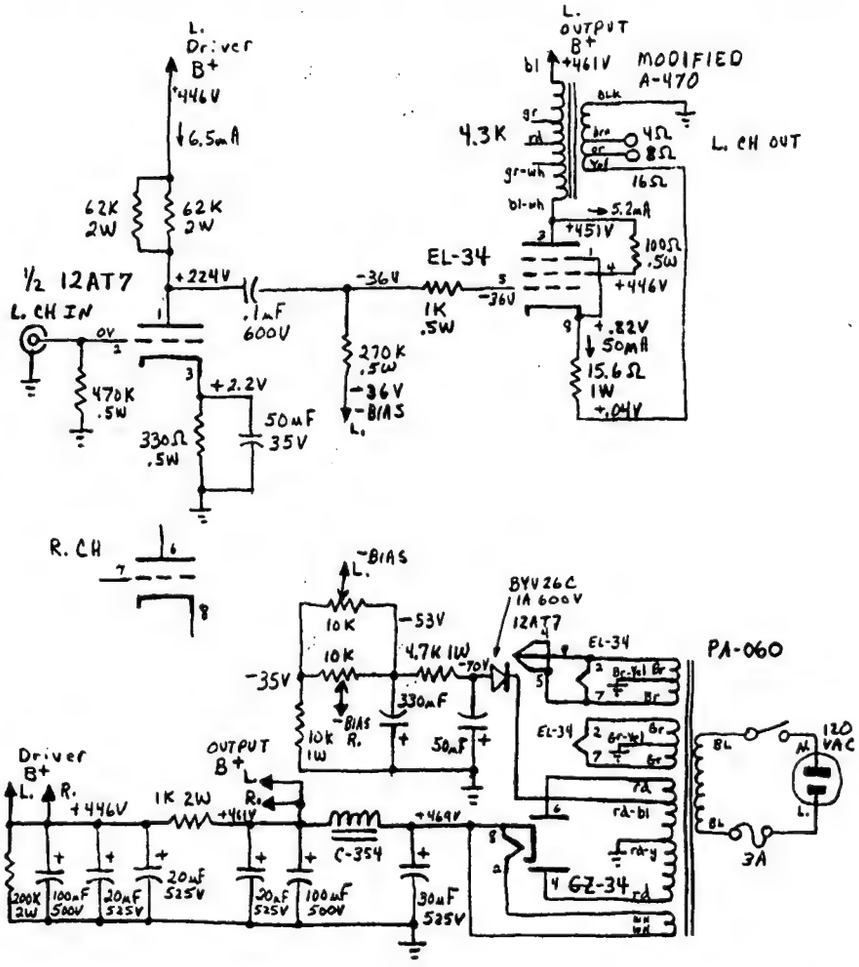
Then I checked the ST-70 on the test bench. The amp had a bit of a problem putting out full power. While troubleshooting the problem, we uncovered a design flaw that causes premature 7199 failure (*see sidebar*). Ironically, the "failed" 7199s sounded better than the new RCA tubes that I installed. My theory was that the unbalanced phase splitter drove the PP output stage toward single-ended operation. The old tubes were much smoother and warmer sounding. The person that sold me the amp heard the difference and agreed with me.

We tried operating the EL-34s in triode mode by disconnecting the screen from the output transformer and tying it to the plate through a 100 ohm resistor. The feedback cap from the transformer screen tap connection was left intact.

Then we tried running the amp with the main feedback loop open and the 7 kHz pole at the input pentode removed. Measured open loop performance was hopeless. The damping factor had dropped to 1.5. The new frequency response was down 3 dB at 42 Hz and 26 kHz. I didn't even want to try to listen to my ported 2-way speakers with an amp with that low a damping factor.

I looked at commercial mods, but I decided that mod kits with excess gain were only going to make my amp sound more like a transistor amp. I spent a lot of time thinking about what I could build on this chassis that would be better than stock. I wanted a simple circuit that used the stock Dyna parts and sounded great. While tinkering, I continued to enjoy listening to my Dyna with "bad" 7199s, a JVC XL-V161 CD player, and some old 91 dB sensitivity KLH Model 33 loudspeakers.

Next I tried a variation of the triode mod mentioned above but with the global FB



ST-70 SE

100 uF 500V caps are Nippon Chemi-con 82DA
BYV 26C - Newark Electronics
Resistors carbon comp from Newark
0.1 uF/ 600V MIT RTX - Parts Connection

DAVE MCDONALD
MATT KAMNA
2/4/96

disconnected and feedback from the output transformer secondary back to the EL-34s installed to improve damping factor. I tied the 4 ohm taps to ground. Then I connected the 16 ohm taps to the EL-34 cathodes through 15.6 ohm resistors.

In this configuration, the driver circuit was simply not up to the task of driving the triode-connected EL-34s. I came to the conclusion that the 7199 drivers were hopeless without some heavy circuit changes. I feared that the circuitry was going to get more complex.

Another thing I didn't like about the stock ST-70 was that the power transformer ran way too hot. While pondering how to relieve the heat problem, I had a flash of inspiration. Why not remove two EL-34s and go single-ended? The B+ and filament draw would be cut drastically.

Typically, single-ended amps require an air gapped output transformer to prevent core saturation under DC current. So I carefully disassembled the output transformer laminations and put then all back together with all the "E"s on one side, a .010 inch spacer in the gap, and all the "I"s on the other side of the spacer. I hooked up the single EL-34 in "100 ohm triode mode" with 3 dB feedback around the output tube and transformer

Hum increased because there was no global feedback and no push-pull cancellation of B+ ripple in the output stage. A 100 uF capacitor was added in parallel to both the output and driver B+ supplies to reduce the ripple and make the unit much less objectionable to listen to. The selenium bias supply rectifier was also replaced with a fast, soft recovery diode to increase reliability. The bias supply output filter cap was increased in value to 330 uF.

At first, we tried to use the triode section of the 7199 as the driver. Using a pentode driver stage was not even considered, but the 7199's low mu of 17 made it unsuitable for a simple single gain stage. We switched to a 12AT7 driver circuit used earlier for driving the really low gain 300Bs. One section of the dual triode was used per channel.

We sifted through seven EL34s to get the best results on the test bench. The old leaky paper coupling caps were replaced by some new MIT polystyrene jobs. In the process of making the modifications, some of the traces were cut off the old phenolic circuit board. There was no going back to the stock circuit. This was either going to work and sound good or not. Now we were ready to listen to a single-ended Dyna amp!

Initially we listened for a while on a highly modified three piece CD player and a set of tweaked Spica TC-50s. Then it was off to dinner and another fun D.I.Y. O.T.S. meeting. A group of a little over 30 people showed up for the event where the amp was very well received. The system used had a slightly modified CD player and Lowther horn speakers with about 100-101dB sensitivity.

Then it was time to try it at my house on the JVC player and KLH speakers. Later it was tried on the Spica using the JVC player. The KLHs played louder, but the Spicas were more controlled in the bass and had a different sound overall. Using the 84dB sensitivity Spicas required turning up the volume to hear very quiet sections of classical music. Then during loud sections of the music clipping was heard. When overdriven it sounded better than a solid state amp, but not as good as some other tube circuits.

We listened to a variety of music: jazz, classical, vocals and soundtracks. The midrange was smooth and it also had a good response at both the high and low end. It was easy to just sit back and listen. Several listeners commented on how different it sounded from the stock Dyna.

The power transformer runs much cooler now, and all of the original magnetics were utilized, even if they are modified. I have been enjoying listening to this new single-ended amp and expect to do so for some time to come.

Perhaps you will roll your own SE Dyna and maybe think of further refinements to try yourself. For example, we paralleled the EL-34s to increase the output power. In order to optimize power and distortion it was necessary to move the plate connections down to the screen tap on the output transformer primary winding. This yielded 16 watts at 5% THD and 14 watts at 1% THD.

ST-70 SE Measured Specs

10 Watts output @ 5% THD @ 1kHz
6 Watts output @ 1% THD @ 1kHz
Voltage gain 17.5dB
Residual hum and noise 1.2 mV RMS
Damping factor 3.8
1 KHz square wave response looked excellent
Freq. response - full power bandwidth
-3dB @ 15 Hz and 60 kHz

Save those 7199s!

by Matt Kamna

This article was prompted by wondering why virtually every Dynaco ST-70 I serviced needed new 7199s? Although the Dyna MK3 uses a different tube (6AN8A) it may have the same problem, as it has an almost identical circuit.

My first thought was they must be pushing the tube too hard. A few quick measurements and calculations indicated that the tube is being operated well within its power dissipation limits. Yet, under test some 7199s would show heater to cathode leakage as low as 100K ohms! This H-K leakage resistance is in parallel with the 1% matched 47K cathode resistor, thereby lowering its value and reducing drive to one of the EL34s. This results in a 12% loss of output power and a 25 dB increase in second harmonic distortion!

Further investigation showed cathode voltages routinely over +100 volts DC and as high as +135 volts DC. The maximum heater to cathode rating for this tube as well as many others is 100 volts. Remember the oxide coating is very thin. Once the 7199 has become leaky, no mod will fix the tube.

Here's how to check the 7199 leakage in circuit. This test assumes that there is typically less than about 6 uA leakage from all the other parallel circuit components.

Place a 100K resistor across the leads of a 10 Megohm input resistance digital multimeter. Set the meter to the 20 volt DC scale. Place this parallel setup between the chassis and pin 1, just below the key, of the front panel octal socket. Polarity does not matter. Just ignore the polarity of the voltage.

You should expect to see less than about 0.6 volts, which equals 6 uA. None of my tube manuals list a spec, but a similar tube has a 25 uA maximum. This would be a 2.5 volt reading or about 4 Megohm of leakage. After all this, don't forget to check the other channel while you're at it.

If you have to replace the tube, you will want to protect the new one by elevating the filament to about +75 volts DC. This is most easily done by using a resistive divider off the output stage B+ supply. Connect a 390K 1 watt resistor between

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the B+ and filament center taps, and a 82K 1/2 watt resistor from the filament center tap to ground. A 1 uF 200 volt capacitor connected across the 82K will reduce the divider output ripple and unwanted signal when full power, very low frequency notes are being reproduced.

This mod can be conveniently installed at the terminal strip where the dual .02 uF ceramic cap was connected. Minor rewiring is required to use these lugs.

I wonder how much of the blame for today's limited supply of these tubes can be traced to this unfortunate design deficiency in the Dynaco amps? Performing the mod outlined above should help you get the normal expected tube life out of those increasingly rare and expensive 7199s.

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To Be, or Not To Be, Linear!

The Single-Ended Transformer

by Dr. Tom Hodgson

This is a sequel to my historical note in *SP* #5 on the pioneering work of the late Dr. Partridge on transformer distortion. For those who missed that article, Partridge in the late 'thirties pursued the concept of larger than normal airgaps in push-pull (PP) output-transformers (OT). The airgap reduced the primary inductance and so his OTs were larger. His OTs for the 10 watt PP Williamson amplifier, which used triode-connected KT66s, weighed 14 lbs. for the EI laminated and 10 lbs. for the C-core designs respectively!

Partridge showed that OT distortion was worst at low frequencies and he even suggested a figure of merit or index for OTs using an inductance measurement at the line frequency for the design full-output power. (The industry did not adopt his recommendation). He put amplitude distortion ahead of flat amplitude response since, as he pointed out, for PP OTs the odd-harmonic distortion could subjectively swamp the fundamental at low frequencies.

The part of his work that really attracted my attention was, I quote, "Instead of having an inductance that varies enormously with the signal voltage; with an air-gapped (though larger) OT the inductance remains sensibly constant." He felt that now he could trust the low intrinsic distortion of the transformer and concentrate on the driving output-tube circuit. His theory showed that the plate resistance of the output tube(s) is the primary cause of voltage distortion at the transformer output; and so triodes with plate resistances of order 1kΩ were superior to pentode output tubes because of their plate resistances of order 10kΩ.

My previous article applied Partridge's ideas to the single-ended (SE) OT and in particular the BH magnetization characteristics of gapped and un-gapped OTs (please note that in the first printing figures 1a and 1b are reversed). Since writing the first article I have tried to find a simpler way of describing the electromagnetic difficulties in the operation of a SE transformer, and why SE amplifiers may sound as they do. This view is presented below, together with some magnetic measurements which I have made on two SE transformers, courtesy of Mike LaFevre of Magnequest and Peter Qvortrup of Audio Note, as well as measurements on a poor design.

What one requires of a transformer is that it should be a linear device. Let us view the magnetic properties of the iron as an output voltage V (like the flux density B) versus an input current I (like the driving magnetic force H). This graph is the same as the output versus input characteristics for any electronic device. It can look something like figure 1, which is an approximation to the BH loop for modern OT silicon iron without air-gapping. The characteristic is far from linear. At small signal levels a PP amplifier might have strong odd-order harmonic distortion (the dreaded "crossover" type). At very high signal levels corresponding to the magnetic saturation case for the iron (which occurs at flux densities of order 15 kilogauss) the signal will clip again with strong odd harmonic distortion.

Note the scale of the horizontal axis where I have suggested DC current values of only a few mA to saturate the PP OT iron. Partridge's suggestion of a significant air gap, as well as the use by Peerless of a few permalloy laminations as used in the 20-20 Plus OTs (thanks to Mike LaFevre for this historical note), all help to linearize the PP OT.

Figure 2 shows the case of the SE OT, which has a sizable air-gap, of order 0.006 inches or more, in the iron circuit. The DC current is put to work driving the air gap and this "biases" the input signal over to the right. I have selected the value of 50 mA DC as the design value of the tube DC current for this SE OT. Note that figure 2 has a "dummy" origin along the x-axis, and shows the high slope of the non-gapped iron (high permeability μ) as compared with the now linearized SE OT characteristic.

As I stated in *SP*#5, SE seems to be a very attractive proposition since it eliminates the DC and AC balancing problems of push-pull designs, together with the PP collapsing magnetic fields which can lead to crossover distortion, etc. But there is a penalty for choosing the SE way. As a result of the air-gap, more AC current has to be applied to the primary for a given transformer. To express this point another way, the inductance of the air-gapped transformer drops significantly for a given size. So one has to have a *bigger* transformer than the PP case for a given design value of primary inductance. (Actually, the slope of the line in figure 2, which represents the permeability μ, is clearly much lower than the PP case). Typically the SE OT of figure 2 would have an inductance of one-third of its corresponding PP design.

Figure 2 also shows that a linear output results from the input, see the sine-wave applied at the DC "bias" of 50 mA. This might correspond to a DC flux density of 8 kilogauss, say, with a peak-to-peak swing in AC flux density of ±0.5 kilogauss. Note, however, that for a given SE OT design one cannot increase the tube DC current too much otherwise the output signal distorts due to magnetic saturation, mainly second harmonic distortion this time (see the 100mA DC current value). This latter case is unlikely, see below. With this simplified overview my measurements of the SE OTs should be easy

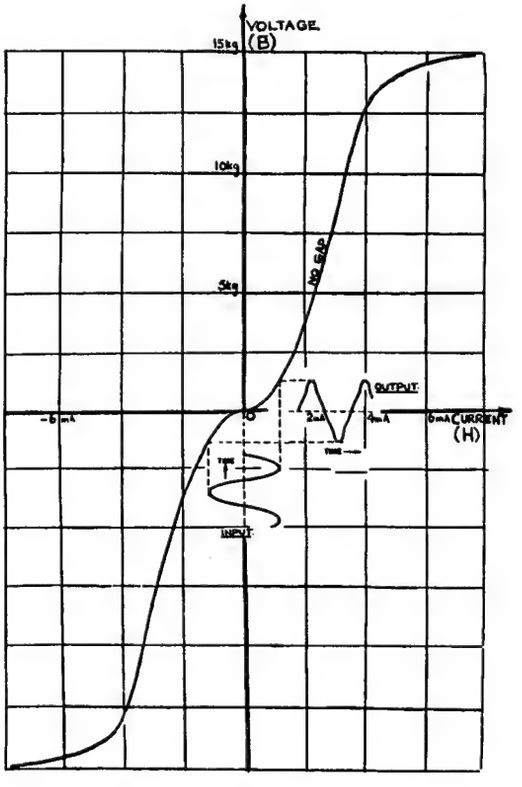


Figure 1. Input/output (BH) curve for PP OT with no air-gap

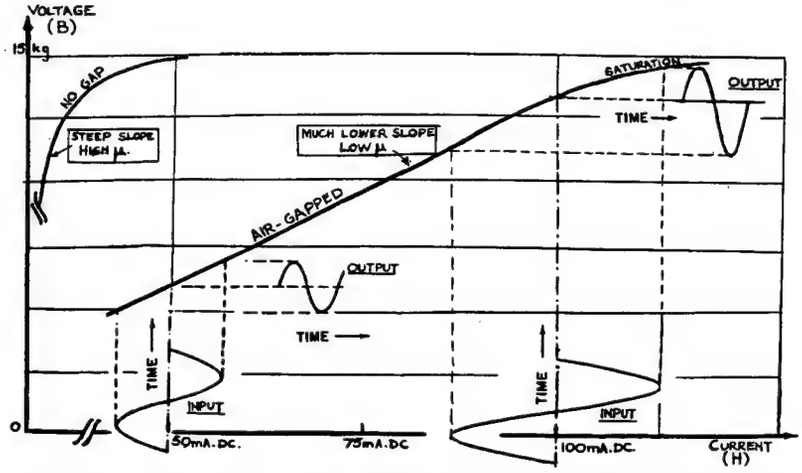


Figure 2. Input/output (BH) curve for SE OT with air-gap. (Note expanded x-axis).

to follow. We need the SE OT to be the so-called *linear inductor*, that is, its BH curve should be a straight line so that the primary inductance does not change with signal voltage, and better still it should remain constant over a range of output tube DC current.

This is demonstrated in figures 3 and 4 which show the BH characteristics for the Magnequest FS030 3kΩ and Audio Note 25W 2.5kΩ SE OTs. Following Partridge I excited the OT primaries with a 60Hz line variac of almost zero impedance. I monitored the driving current *I* and, by integration of the OP voltage, obtained the flux *B*. My results are taken from the x-y traces on an oscilloscope. This follows the standard testing procedure given in electromagnetic texts: the AC flux density swing was of order 15% of the DC value for the very large excitation voltage of 141 Volts RMS (±200 Volts peak). This is at least double the value likely to be encountered with output tubes like the 300B etc., so any non-linearity will be immediately obvious.

There is no doubt that the OTs are linear inductors even when the DC current is at least 50% higher than the design current. The Magnequest is a particularly conservative design. Even at excessive values of DC current both transformers show only slight (2nd harmonic type) curving-over of their BH characteristics. And remember you are never likely to drive these transformers as hard as I did in my tests. Both are excellent OTs.

Following Partridge, I calculated the voltage distortion at the design DC current values for both OTs with results below 0.1% when driven by a 300B. For typical music signals the distortion is probably below 0.02%. Therefore, in my view, a well-designed SE OT such as these *does not produce distortion* driving normal output loads.

To further demonstrate that a good SE transformer is linear I have plotted the measured primary inductance versus output tube DC current in mA in figure 5 and versus signal rms voltage in figure 6. The results are self explanatory and should answer the often asked question of how close to the design value of tube DC current should one operate? I hope my measurements have convinced you that these OTs are linear inductors as seen by, say, a 300B output tube. Any distortion (which will be worst at low frequencies) will come from the tube. That was the message of Dr. Partridge's work. Both of these transformers are fine devices.

So what should you expect in a good SE transformer? First, I will make a comment regarding the primary inductance, core size and the low-frequency roll-off of the amplitude vs frequency response. The -2 dB point at low frequencies is given by Sturley, *Radio Receiver Design*, Vol. 2, as:

$$f_{-2dB} = \frac{2 \times (\text{plate resistance})}{2\pi \times (\text{primary inductance})}$$

For a 300B, if Rp = 750Ω and L = 30H, then f_{-2dB} = 8 Hz. I hope it is obvious by now that low frequency response costs money in an SE transformer.

With apologies to all electromagnetic scientists since I have no name for this law, if one multiplies the transformer weight (lbs) times the primary inductance (H) one obtains a kind of figure of performance per dollar cost. It is equal to 352 per $300 for the Magnequest and 176 per $150 for the Audio Note. (Actually the weight of the transformer is a rough measure of the core size and the amount of wire in the windings). Given today's prices, my "figure of merit" is around 1-2 for a chosen silicon iron OT (less for more exotic designs).

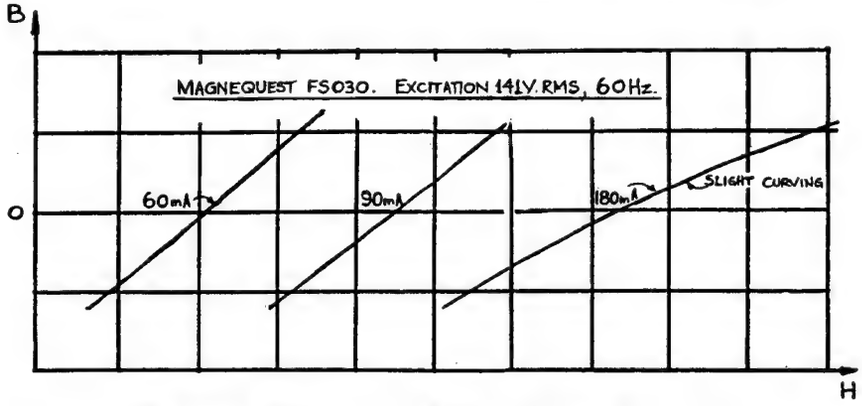


Figure 3. Magnequest FS030 — Cost = $300 Z = 3kohm Wt = 11 lbs
I_{DC} = 60mA Core size = 1.5" x 2.25" Primary L = 32H

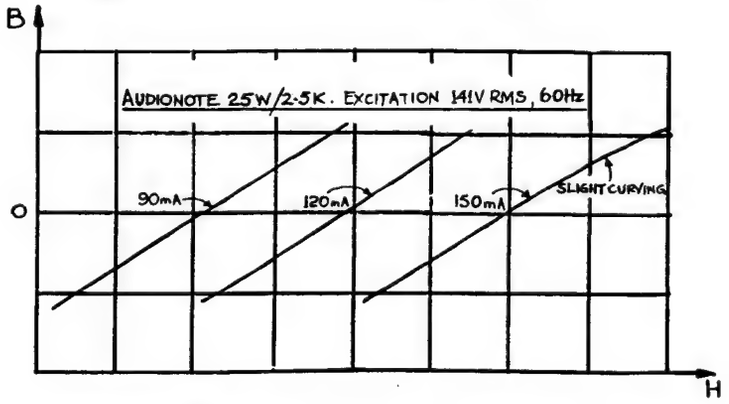


Figure 4. Audio Note 25W — Cost = $150 Z = 2.5kohm Wt = 8.8 lbs
I_{DC} = 90mA Core size = 1.5" x 1.75" Primary L = 20H

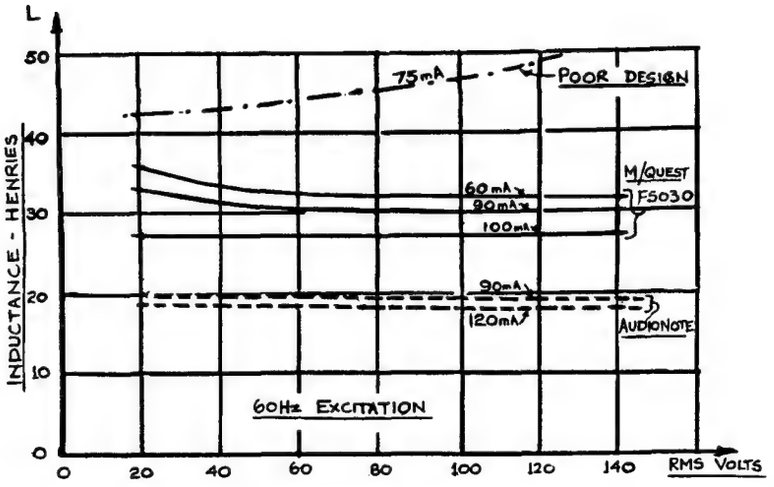


Figure 5. Inductance measurements for given dc current vs. excitation rms volts

To give an example of a "poor" design of a SE OT with non-linear characteristics, figure 7 shows a transformer with 54H of inductance for I_{DC} = 75 mA, wt. = 8.6 lbs but with only a 1½ inch x 1½ inch core-size. Would you use this OT if it cost only $80? The figure of merit is 54 x 8.6/80 = 5.8! Wow, what a bargain! You can really think you are a cheapskate! Now look at the BH curves in figure 7. One is now close to the iron saturation region with a distortion at 60Hz of order 1% or greater at the design DC current value of 75mA, predominantly 2nd harmonic which produces some frequency doubling and a dark sound. What went wrong?

This is easy to answer, one cannot obtain such a high primary inductance (this also takes a lot of primary turns) with such a small core area. But with a small increase in air-gap which drops the inductance to 38H, the transformer is quite linear. (There is another factor which involves the primary and secondary wire resistance which leads to a loss factor. Remember a 1 dB power loss due to wire resistance doesn't sound much but it is 20% of your 300B's input power to the transformer. Typically you need an insertion loss factor of order <0.5 db = 10% loss).

This brings up the subject of the output tube load resistance. Values of 2.5 to 3kohm help the OT designer since the turns count is lower, the wire diameter can be larger. Parallel 300Bs are a good idea as far as this point goes. The 16 kilohm transformer for the Ongaku SE amp (*SP*#2) must be a real artwork item. Yet, I am told, it rolls off above 12kHz. Again I make the point, leave SE transformer design and manufacture to the experts. But I hope this helps in what to look for in choosing a transformer.

Of course, other parameters are important like high-frequency response. Here I have been primarily concerned with the linearity of the transformer at low frequencies where most of the trouble arises. The SE transformer designer has a tougher job at high frequencies since one is not able to employ the cunning inter-winding tricks available in the case of balanced PP designs to reduce leakage capacitance and inductance.

I measured the approximate frequency response of the Magnequest and Audio Note OTs using a 1kΩ resistance in series from an oscillator with 5V rms drive (strictly one should use the output power tube to do the driving) at the design DC currents. Both OTs rolled-off around 35kHz, the Magnequest was flat at 20Hz (because of its higher inductance) while the Audio Note had attenuation of 1.5dB. I also looked at Lissajous figures for both transformers in order to examine the phase at low and high frequencies. The phase angles agreed with the amplitude responses and nothing unusual was observed.

I am still leaning toward the belief that the main advantage of SE may be the excellent linearity for small signal levels. Does this explain the greater musical resolution that can be obtained as reported to date? At low and high frequencies there may be driving problems, certainly favoring horn loudspeakers. I still hope that *SP* readers will have things to report on this matter as more experience is gained listening to SE designs.

Reading between the lines of *SP* magazine I seem to detect a recommendation for a feedback push-pull amplifier for the subwoofer and SE drive for the rest of the music spectrum (unless you have K-horns or Lowthers). I have recently heard two excellent SE amplifiers driving original Voigt corner horns, one used a DA30 output tube, the other used an 845. The bass was noticeably more prominent, much more so than with the excellent PP designs used as a comparison. The SE designs seemed to have more low-level resolution, a more "you are there" presentation with greater depth. Most of the differences probably come from the output triode tube producing 2nd harmonic distortion from its own plate characteristics, *it is not the output transformers*!

But now we know the great failing of the current CD format, i.e. lousy low level resolution and harshness due to zillions of "intermodulation" products (thanks to Keith Johnson in his recent interviews). Is there a vinyl recording expert anywhere who can explain how the great LP recording engineers achieved depth, despite many wonderful, early stereo recordings being in mono at low frequencies? When I know this answer maybe I can R.I.P., but still listen to the music.

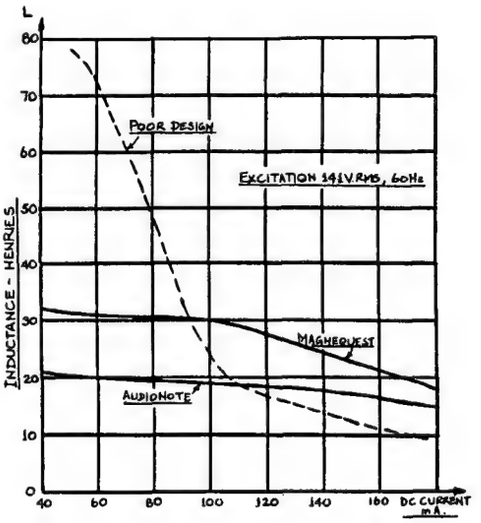


Figure 6. Inductance measurements for given 60Hz excitation volts vs. dc current

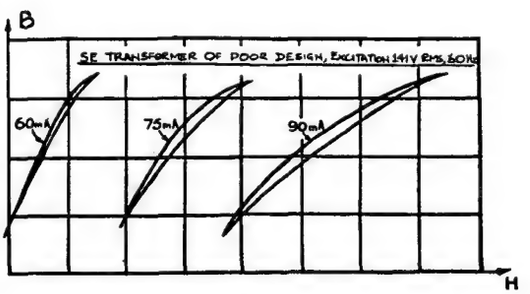


Figure 7. BH curves for different dc currents Cost = $80 Z = 3kohm Wt = 8.6 lbs I_{DC} = 75mA Core size = 1.5" x 1.5" Primary L = 54H

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6.8K, 50W, 845 etc. PP, $180
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5H/400mA, $60
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.00018/630V, $6
.0004/630V, $6
.00082/630V, $6
.0015/630V, $6
.0047/630V, $6
.012/630V, $8
.015/630V, $8
.022/630V Silver Leads, $12
.033/630V, $7
.039/630V, $8
.047/630V Silver Leads, $14
.056/630V, $8
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.36/630V, $15
.39/630V, $16
.47/630V Silver Leads $20
.018/1000V, $11
.22/1000V, $15
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Casual Reactions



by Herb Reichert, Audio Note NYC

"Who made me?"

Reckon me this *Sound Practices* readers. . . "Who in world of audio fringe persons am I writing for?" The editor is not deep into market research and Joyce just says they get letters from a "broad spectrum". So who in audio hell is reading this and what are they really interested in? My best guess is that you guys are really smart (or at least hard working), really love music and are probably more than a little eccentric. In any event, let me start by thanking you and *SP* for giving me the opportunity to learn to write and practice my shaving on someone else's beard.

I don't know your faces, I have never been in your basements, so I just write about my own experiences, hoping there is something that I have done or learned that will inspire others to action. A lot of audio writers hope to educate and opinionate their readers. Me? I would rather see some action. I want to see people finish an article, then get up and do SOMETHING! Try something new and learn from the experiment. I do not believe I can *teach* anybody anything. What I can do is suggest actions and experiments that might lead the reader to his own discoveries. For me, learning to write is about learning how I can be of service.

You may not realize this, but *SP* is maybe the most esoteric magazine in the world. Directly heated triodes, bright emitters, dull emitters, tractrix horns, big chunks of air-gapped ceramic leaf steel, paper in oil condensers, ion-transfer capacitors, beeeeeeeee serious! Try to talk to some new fashionable acquaintance about this stuff. They be pulling their hat down and putting up their hood and crossing the street next time they see you. This is a very serious problem. So, let me tell you about how YOU changed the history of audio and while you may be a little weird you can sleep peacefully with the thought that you contributed to an important cultural change.

Everybody's talking...

Single-ended triodes and horns—five years ago I couldn't give them away. Ten years ago even J.C. Morrison was laughing. Joe Roberts was selling Krell and Gordon Rankin was designing mainframe computers. To say things have changed is an understatement. *SP* readers have changed the history of audio. For the first time ever, an industry has been transformed from the bottom up. A true revolution of the hi-fi proletariat.

In this case, the revolution started in basements of the audio poor and is now on the tables of manufacturers' boardrooms. Manufacturers did not invent SE triodes as the latest and greatest ploy to extract your savings. Reviewers did not "call" for a change. How come nobody in the audio mainstream 'noticed' what was going on in Japan for the last 20 years. All the big guys like Krell, Audio Research, CJ, etc. go to Japan every year for the trade shows. Did any of them come back and say, "Hey, you won't believe what I heard?" There was an audio 'cold war'.

That is how this single-ended triode "new dawn" began. A few western culture music lovers with open minds heard (or heard about) Japanese style 'ultra-fi' systems and built their own and the concept spread one record at a time, one music lover at a time. Up from the basements and into the living rooms. About two years ago I swore I could hear men all over America yelling at each other, "Yeeow! This is amazing. You are telling me this is 5 watts? No feedback? You're nuts!!! If you build another amp, can I buy this one from you?"

Peter Qvortrup and Jean Hiraga were the early Western pioneers of SE amps and efficient speakers in the UK and Europe. Later, Herb Reichert, Dennis Had and Gordon Rankin started manufacturing SE 300B amps in the U.S. And the whole time, the entrenched giants of the market were laughing At about the same time, you guys, the *SP* readers, started soldering and sawing and demonstrating the 'new way' to so many people on a local scale that the mainstream press had no choice but to notice.

Now, Carver Corporation makes high power solid state amps with the "soul of a 9 watt triode" and Jadis makes SE 300B amps. Think about it. What many of you discovered for yourselves alone at night has affected the thinking and products of an industry giant like Carver . . .and this is just getting started!

The most amazing aspect of this is the *WHY* it happened not the HOW. Nothing in the history of American hi-fi is nearly so radical as this triode/horn revolution. You see, this is NOT A "RETRO" MOVEMENT. Before *Ongaku* no company *ever* sold a directly-heated, single-ended triode product in the American high-end market. Sansui and Pioneer sold economy-model single-ended receivers in the 1960s and Brook sold 2A3 push-pull amps in the fifties and that is it folks. The Western Electric gear was lease only and went into theaters. As far as American music lovers sitting in front of SE triode amps listening to recorded music, you are the beginning.

The mainstream reviewers who are in a last minute scramble to get hip about SE triodes are hooking these flea powered amps to stupid, slow, long excursion, low impedance speakers and saying they are "nice and sweet and pretty" but maybe "not too accurate". WRONG! These amps are lightspeed fast and trace signals like super race cars. A well-designed single-ended amp is so much more accurate than its hi-fi ancestors it is shameful! What you are getting with these amps is gobs more information. More leading edge definition. More harmonic development. More color and texture.

The reason people are so taken when they live with a quality SE design is these amps do not lose the vibratory life force of the music. These amps recover a breathy sort of energy that pressurizes the room, even with small speakers. You know the effect, when you put the tonearm down on the record and you can feel the room pressurize even *before* the orchestra starts playing. This is the magic of the triode horn experience. The triode thing is not about fun or nostalgia it is about heartbeat, rhythm and intensity. It is about music that LIVES.

Here is the real joke. I predict that by the end of 1996 you will see the big backlash. The old guard, royalist, solid state feedback rammer jammers will be engaged in a slam campaign. Instead of looking ahead, being creative, and trying to enhance musical culture in the home, they will be defending the technological monarchy. I am predicting a real war of concepts. The big tube companies like CJ and Audio Research will bring out

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300B amps, because they have no choice. There a no more quality 6550s or EL-34s and there are few new engineering concepts to apply to this technology.

The solid state guys will have to make some serious 'kick ass thumping' power amps because they know that this is the one and only thing they *might* have over triodes—forget finesse, we got the slam! The near-sighted speaker manufacturers will be going Chapter 11 (as usual) and the reviewers that hooked their wagons to the wrong horses will be looking for new day jobs.

I think it is art

Triodes and horns are capturing the imagination because they let us like music again and because they are beautiful to look at. Personally, I would pay $20 just to see a picture of an all-out Japanese horn system. Check out Ikeda's system on the horn speaker home page![1] What fantastic shapes! Boxes and panels can never excite the sculptural aesthetic like a horn. An EL-34 will never touch a 300B or 211 tube for cachet. Transistors look boring. Triodes look Frankenstein wild. They will never make a coffee table picture book of solid state amps or box speakers. They make them for triodes. The simple SE circuit schematics are also beautiful. SE circuit design is not about damage control and error correction, it is about preserving the ecology of the music signal. Make it more and more simple and use better and better parts.

Pioneers in single-ended amp design seek to preserve the 'continuousness' of the music. They work to rid music reproduction of the mechanical and the electronic artifact. I am convinced that most of us had let high end audio distract us from the structure of the music and the inspiration of the performance. The single-ended amps of today are only the beginning. The door is open just a crack and I believe that you people, the brave radical ones, who read this magazine are the ones who opened the door. Thank you all for getting up from your chairs and doing something important. When the history of 20th century audio is written you can say you were there at the front line.

1—http://invalid.ed.no/~dunker/horns.html

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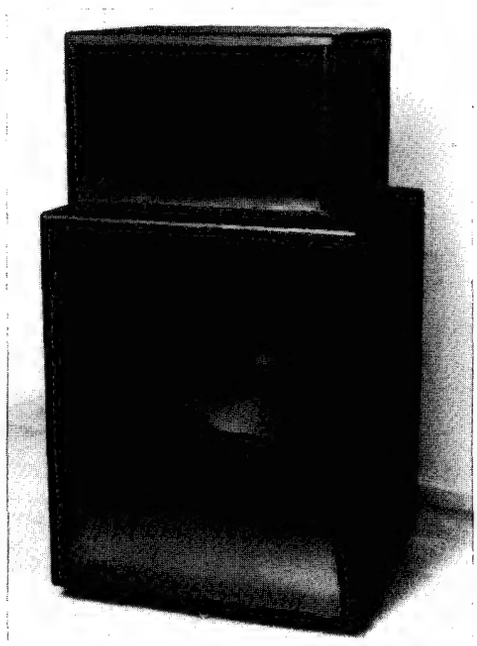
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TURNTABLES (continued from page 14)

the audiophile way to construct a driving unit to minimize these errors.

After using a Platine Verdier for six years now, I definitely lost that down-to-earth feeling. I wonder why so many American freaks creating great amps and speakers never felt the necessity to match them with a high-end turntable. Bringing a 300B amp to perfection or taming a VOT— is that down to earth or up to audio heaven? Anyway the best advice I can give to you is:

1- Sell any Garrard, TD 124, and, in my humble opinion, Linn, or place them in your private museum. Don't mess up those old goodies!

2- Start with a Xerxes by Roksan, if you don't want to jump forward to a Platine Verdier. Xerxes still has one of the finest bearings I've ever seen in a commercial product. You can buy a bearing and inner/outer platter assembly from Roksan and mount it on a subplatter of your choice [Roksan distributor in US: May Audio Marketing, 423-966-8844/8833 FAX. Approximate cost of platter and bearing is $600).

3- Find a good engine or use the Swiss-made 24V Maxon part # 2326 942-12-111-050 [available at $231.10 in single qty. from Maxon, 838 Mitten Road, Burlingame, CA 94010 415-697-9614.] You can try the much cheaper "941" 30V version if you are confident that you can build a low voltage regulator. Christian Rintelen of *Hi-Fi Scene* uses the rare and expensive "949" 42V version. The Maxon is #3 in my chart and it will serve as a classic in all applications. Avoid Pabst.



Realization of Audio Contact, Germany

4- Try a home-spun driving unit as described above, using tape as a belt. The optimum tension is where the platter runs at the lowest voltage. Use the best pulley you can get, even if the cost is excessive. For the Maxon motor, I recommend a pulley of 9mm diameter. Audio Contact in Germany can provide a ready-built pulley of this size and they also sell engine/pulley systems. (Audio Contact, Lindenweg 12a, D-22395 Hamburg, Germany).

5- Build a variable regulated power supply which can be as simple as an LM 317 chip or as complex as you wish.

That's it! Most probably this will outperform 301, 124, LP 12, or whatever you name. If you're out for the top turntable, you will have to build it yourself. That truth is simple and always the same. I'm sure you can do it and without becoming a mechanical engineer.

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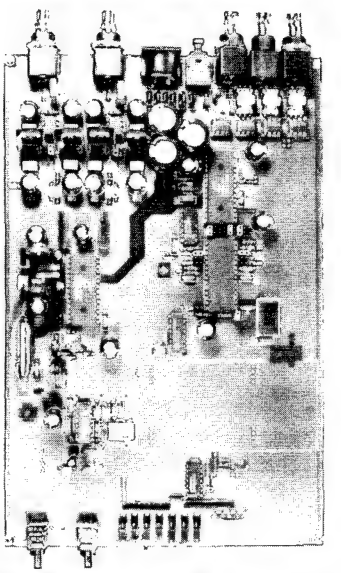
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BETTER THAN OKTOBERFEST?

I just finished reading through all the issues *SP* published yet and would like to congratulate you on its fascinating contents. It sure is a shame none of my friends urged me to read *SP* earlier. Since I am more into speakers than amps, I would like to pass on my thoughts on what I read on horns while the others cherish the lasses at the beer festival.

i) Altec upper range: I found the 288C the best driver overall, if you want a finished product. Faster and more dynamic, though, is the old alnico 290 driver sans xformer and with an 288 alu dome glued to it. My own pair also has a very thin (~2μm) layer of silver applied to the poles (idea taken from JBL LE 85/2420) for even better HF performance by lowering coil inductance; it goes up to 18k @-6dB, which puts the question of sacrificing homogeneity by going 3-way to rest forever. That is, if you can live without an 8 to 15 cell horn for broad dispersion duties. Try 311-90 or 203 instead; 311-60 has some 3 to 4 dB lift on axis at 1 to 3 kHz, depending on driver/diaphragm used, but is OK otherwise. For low cutoff, try 290 or 288 with resin diaphragm on 1503 or 203 horn using steep (I mean steep) active x/o at 240 Hz.

ii) Altec phase plugs: I do not agree with the somewhat generalized view held by some of your correspondents, namely that on 1" drivers the WE-type phase plug is better than the tangerine; the best Altec 1" I know of is a 808B alnico + tangerine with 891318 ass'y (nearest equivalent is an off-the-shelf 802G driver). Although Altec's literature of the day claimed extended "high-end response while significantly reducing distortion", the midrange through a WE-type phase plug is indeed slightly clearer, the first claim nevertheless holding true. Contrary to what has been implied, an aluminium 1" works best into 511, not 311 horns, the latter sounding rather slow and restrained (overdamped?); also, the 802G top end is not better than that of a 1.4" driver modified as described above, if you ask me. I suspect some standard 288C samples might even beat a 1" driver on a 311 or 329 horn @10k, the result largely depending on the sample variations among the 1.4" driver's diaphragms. I haven't tried 1.4" tangerines yet, but comparisons might be misleading, as Altec has changed phase plug and magnet structure more or less simultaneously as opposed to the late 70s transitional time span employed on 1" units.

iii) Tractrix upper range (in the US named after a guy who seemingly likes 4 extra chars in front of his name): First put into broad use by P.G.A.H. Voigt (nine extra) of Lowther fame pre WW2, they offer the most neutral performance I have heard. Since the impedance varies more than with some other types of horn, I'm not sure whether it's a good idea to x/.1st order?!? As far as I know, they were first used with D54 in the 70s in a speaker past IRS price range by a company based in Duisburg now trading as A Capella. Their mid-horns are circular and employ perfectly curved surfaces in glossy white lacquer...a dream! Apparently a guy in Berlin called Martion started doing similar things at about the same time. I tried a like-looking lampshade with Yamaha NS 1000 and 2000 beryllium domes, but as all parts of 'em domes move in unison instead of warping and disengaging their central bits like your D54 does, you really need a phase plug to get output beyond 3k. Back to i), then. Maybe, though, one secret to classic joy of the law is having horns circular, as the Japanese GOTO horns (pure exponential flare laws) are circular as well and absolutely gorgeous at that!

iv) If you have the necessary spare change or are lucky to get hold of one at a giveaway price, try a Pioneer/TAD driver, especially the Alnico/beryllium-domed 4001 2-incher. Said to be the last word.

Ralph Gibbemeyer
Munich, Germany

TWEAKING TOWARD JERUSALEM

I just received issue 9 of *SP*. Speaking out! You know, the Aquarian Age for music started in 1968 and now Armageddon is not too far away anymore. Like Yasser Arafat said himself in Bethlehem; he's only 3 miles away from Jerusalem...

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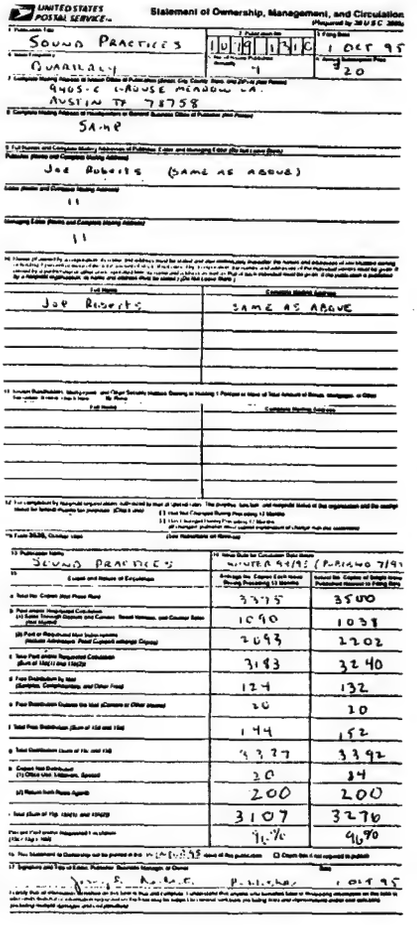
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average speed of 55 miles/h the 3000 pounds heavy car used indeed 300 miles per gallon diesel. The man was 75 years old in 1990 and had to move to Holland because in Germany he became "dangerous"!

This principle on engine technology applied by this former M.A.N. engineer is known since 1925!!! The engine didn't lose any heat. If you placed your hand on the engine block it remained and felt cold. The thermal efficiency reached 85% inside the engine. There were double intake pipes, one row for the combustion and another row of pipes to form a cold air film at the insides of the cylinder to prevent the combustion heat to "escape" through the metal of the engine block, cylinder head, etc. The engine was not water cooled nor air cooled! But it remained a normal 4 stroke, 4 cylinder engine. I've read all this in a "save the nature" magazine. Shortly after this particular edition the magazine "disappeared".

I agree with what is published in *Sound Practices*, I recognize that silver output transformers are better sounding than copper wired ones, but you can't make me believe that Mr. Reichert's casual reaction is crying for audio tranquillity. Is the Ongaku the best amplifier or not? The TRUTH will set you free! Folks, Europe is a lost continent, but don't waste America, right? The baby Ongaku will work excellent, I admit, but don't faint if one day a DIY'er comes up with a $500 SE triode 2A3 amp that outperforms a $50,000 Ongaku!

After more than 70 years of audio development, where are we? Fighting digital jitter and other gremlins? Anyway, I'm going to have another round of tests without test signals. But how will I ever explain myself or the discovery if I find something?

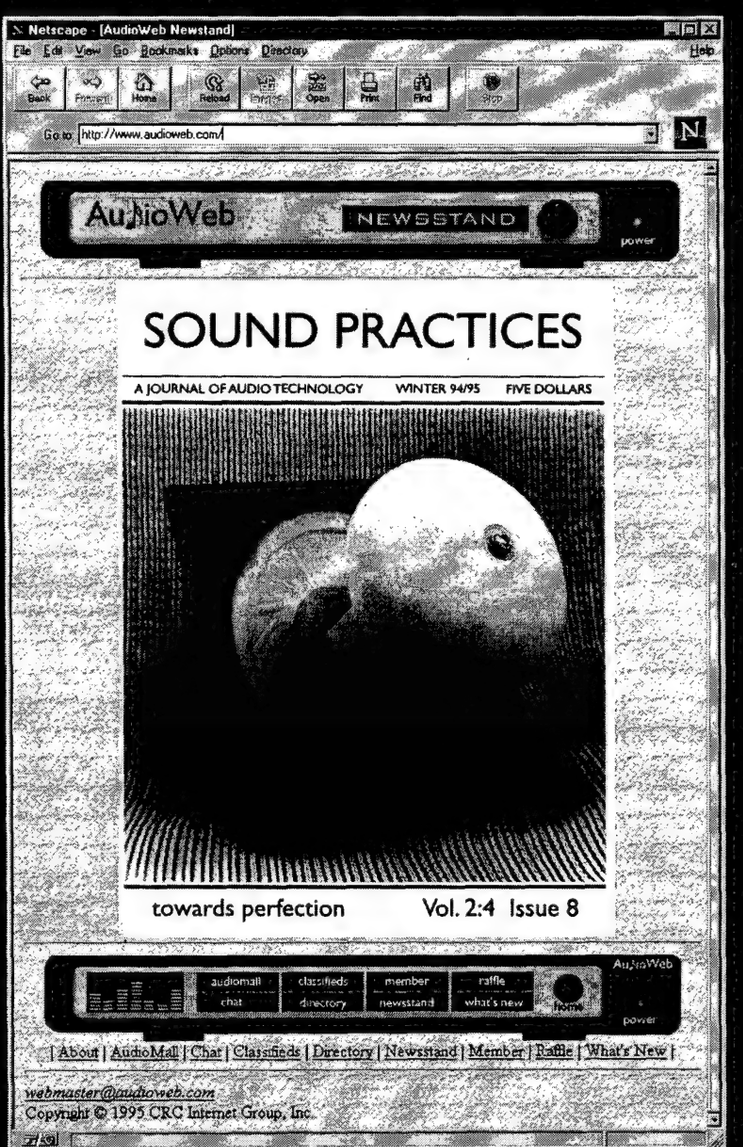
I'm glad that vacuum tubes are alive again but I'm not naive and in fact can we gain the good music again? Will people accept real music if they hear it? Paul Klipsch needed a good 5 watt amplifier for his hornspeakers. It "means" something. I don't know exactly. There are no clear facts anymore, it all became virtual. One thing I know for sure, S.E. triode amps have something that all other kinds or push-pull amps don't have. I keep on searching.

Alex Cockx
Winksele, Belgium

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6SN7WGTA JAN PHILIPS	7.40	5.90	4.90	4.40	3.90		
6SQ7 JAN GE	3.15	2.50	2.00	1.50	1.20	1.15	1.10
6U8a JAN PHILIPS	2.00	1.60	1.35	1.15	.95	.80	.70
6V6GT JAN GE (GLASS)	12.40	9.90	9.50	8.80	8.40		
6X5WGT JAN PHILIPS	1.90	1.50	1.35	1.20	1.05	1.00	.95
12AT7WC JAN GE	6.15	4.90	4.40	3.90	3.50		
12AU6 JAN GE	1.90	1.50	1.25	1.00	.90	.80	.70
12AX7WA JAN GE	9.65	7.70	6.50	5.90	5.40	4.90	4.50
12AX7WA JAN PHILIPS	9.65	7.70	6.50	5.90	5.40	4.90	4.50
12SG7 JAN RCA	1.00	.80	.70	.60	.50	.40	.35
12SH7 JAN GE	1.00	.80	.70	.60	.50	.40	.35
12SJ7 JAN	1.25	1.00	.90	.80	.70	.60	.55
12SL7JAN GE	1.25	1.00	.90	.80	.70		
83 JAN GTE	8.75	7.00	6.40	5.80	5.50		
829B JAN CETRON	8.55	6.85	6.25	5.65	5.35	4.75	4.50
5656 JAN RAYTHEON	7.50	6.00	5.00	4.20	3.30	2.50	2.20
5751 JAN GE	4.50	4.30	4.10	3.80	3.50		
5814a JAN PHILIPS	3.75	3.00	2.75	2.50	2.20	2.00	1.90
6072a JanGE = MIL 12AY7	8.90	7.70	6.50	5.90	5.40	4.90	4.50
6080WC JAN GE	6.15	4.90	4.40	3.90	3.40	2.90	2.60
6188 JAN PHIL=MIL 6SL7	11.15	8.90	7.90	6.40	5.90	5.60	5.30
6189W JAN PHILIPS	3.75	3.00	2.75	2.50	2.20	2.00	1.90
6922 JAN PHILIPS	4.25	3.40	2.80	2.10	1.90	1.65	1.45
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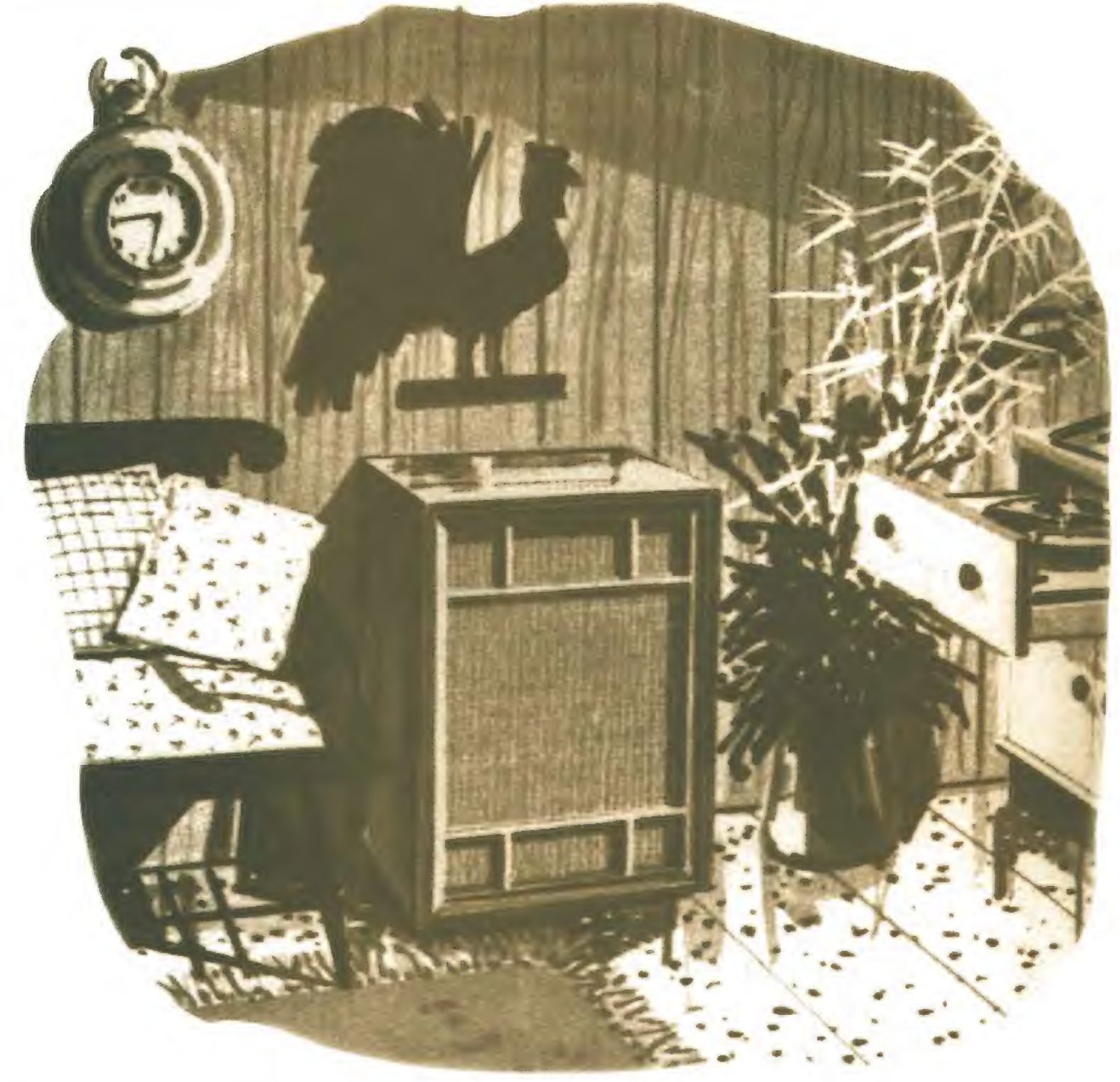
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SOUND PRACTICES

A JOURNAL OF AUDIO TECHNOLOGY FIVE DOLLARS



Exotic Reference Systems

Issue 11

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...and MUCH MORE !!!

The Age of Hyperreality

In a nearly incomprehensible essay about our slow and steady drift away from reality as we knew it towards a fragmentary, unrooted, "virtual" existence, the post modernist Baudrillard observes that the deep problems of high-fidelity audio illuminate and embody the core principles of a universal crisis of being in the contemporary world.

Baudrillard outlines a "stereophonic" model of social practice and argues that we have moved beyond old-fashioned cause and effect related history into a non-linear quasi-reality grounded only in *simulation*, the powerful legacy of modern communication technology and the profound capacities for re-production that our wondrous machines provide.

He uses hi-fi as a metaphor to illustrate how we have gone beyond the "vanishing point" into the era of news over direct experience, digitally created collaborations over live ensemble playing, the triumph of represented experience, in all aspects of life.

> *"We are all obsessed with high fidelity, with the quality of musical 'reproduction'. At the consoles of our stereos, armed with our tuners, amplifiers and speakers, we mix, adjust settings, multiply tracks in pursuit of a flawless sound. Is this still music? Where is the high fidelity threshold beyond which music disappears as such? It does not disappear for lack of music but because it passed this limit point; it disappears into the perfection of its materiality, into its own special effect."* —from *The Illusion of the End*

Baudrillard argues that we now live in a "hyperreality" that is a by-product of exploding media sophistication and our increasing reliance on mediated input to construct what passes for *real*. Read audio magazines and note how we have developed parallel definitions of *real* sound that apply only to reproduced sound, without thinking it unnatural in the least to do so.

Under such circumstances, *reality* as we knew it in a more innocent age is a casualty of technology and our uses of it, erased along with the barriers that space and time *used to* present to sensory experience.

Now, that is a rather heady concept but I can relate to the general trends of the argument from the perspective of an audio hobbyist. We all recognize the distinction between music listening, even if it's "simulated" music, and just geeking out on audio for audio's sake. Both pursuits clearly have their attractions and rewards but they are different adventures. Audio maniacs often ignore the fact that they are not the same thing, let alone indications that hi-fi and music exist in a state of tension, such that one denies the other when you really get down to it. If a jazz master is playing solo piano in your living room, what do you need a stereo for? And if you have a perfect stereo, what use is live performance?

Although it is hardly worthwhile or productive to dwell obsessively on this metaphysical predicament, there is a threat that once we enter the domain of audiophilia, we can never listen to recorded music the same way again. Hi-fi music exists within its own system of reference, one where the answer to the question "Is it live or is it Memorex?" is always obvious yet we continue to ask it in hopes that someday we won't have a ready answer. We can fill in the gaps in reproduction partially with faith and desire, but live music only gets played that way once.

This discussion of the mental postures we adopt in listening reminds me of an interview with drum great Max Roach in the August *Stereophile*. Max related how jazz musicians can't help listening *for* certain things when listening to music. Max spoke as though musical civilians were blessed in their technical innocence while musicians are cursed with an involuntary analytical attitude that puts them into a working mode whenever the music plays. The thrill of music listening, acccording to Max, comes when you listen like a layman, an innocent, because then you can get truly involved in the "feeling of joy of music".

Sounds like the familiar "I, Reviewer" syndrome where obsession with sound overshadows the "feeling of music." The point is that it usually matters more how we're listening and why we're listening than what we're listening with. An obsessive focus on the musicological aspects of performance or the perceptual artifacts of reproduction technology virtually guarantees a non musical experience. In this day and age, we need all the joy of music we can get!

La Voice of the Theater Chez Nous

Taming the ALTEC A5 Classic for Domestic Use

by John Stronczer
Bel Canto Design

When I had the opportunity to hear Jean Hiraga's A5 system in the *Nouvelle Revue du Son* listening room with our *Orfeo 30*, 845 SE amp, I *instantly* knew that I had heard the system that could replace the Spendor SP-1s that have been doing the job in our living room for over 13 years.

Actually, the Spendors officially belong to my wife. She always had a suspicion, totally unjustified of course, that I would go out and sell the old reliable SP-1s in an audio frenzy.

I confess that it was love at first listen with the A5s. I mean I listened to a single bar and I *knew*. When I chose the Spendors it took me about 10 minutes of listening. It doesn't take me much listening to recognize a speaker I can really live with.

In any event, the decision to explore a large scale horn system has proven itself to be a positive step. Music has injected itself totally into our lives through these devices, they are, indeed, the other half of the wonderful music creating possibility of the SE triode amplifier.

No, they aren't perfect, although I am not yet certain if any weaknesses are a result of other system components or the recording or the speakers. These speakers make music completely engaging, without any 'High End' audiophile pretensions in the traditional sense.

Sure they aren't perfect (what is?), but they are so much better than any alternatives, and they play music so convincingly that I just don't really notice or care about weaknesses.

A properly set-up A5 system can make one forget about the little audiophile worries and just listen, becoming engaged with the music, whether Hendrix, Gould, Bizet (opera comes positively alive), Brel, Evans, Miles, Nina Simone, the Beatles, you get the idea, every artist communicates their musical potential through a system like this. The source can be CD, LP, radio or even an old cassette, you will still hear more of the music and the musician(s) than you ever have before.

I am not an audio reviewer, so I won't take apart the performance. Let's just say that they can do everything very well, some things better than any other system I have laid ears on. Overall, they are good enough to make other familiar systems seem Dead End. Instead they incite you to dance or laugh or sing or just shake your head in wonder at the musicianship of a performance.



Actually, after living with our customized version of the classic A5 Voice of the Theater system we have concluded that it would be just about impossible to go back to a more 'normal' type of loudspeaker.

Jean Hiraga's System

How do they do what they do? As an engineer this is the first question that comes to mind when I experience something unexpected. This was what led me to the 845 triode and SE amplifiers some 10 years ago and it is happening again with these loudspeakers. I will describe the system that I heard in Paris and continue by describing what I have managed to assemble, looking at the parts before trying to home in on the whole.

M. Hiraga uses the 828 style bass/midbass cabinet with a Westrex (Westrex was the export arm of Western Electric/ALTEC) sourced 515B type 16" bass/mid driver below 500 Hz, a Westrex 2080 1.4" compression driver (Altec 288 C) comes in at 500 Hz and drives a 1505B, 15 segment exponential horn, and for large spaces he brings a JBL ring type tweeter in above 15 kHz.

The crossover/EQ design generously shared by M. Hiraga was essential for getting a loudspeaker which was originally designed to fill a large theater to make music in a reasonably sized home.

The third octave sweep from the system in France and the crossover circuit from M. Hiraga are shown below. It looks somewhat complex but is really quite a simple and elegant solution to the challenge at hand.

The crossover marries these two drivers very well, yielding a response that is remarkably flat in room from about 40 Hz to around 16-17 kHz. I did not use a ring tweeter, agreeing with M. Hiraga that it is not necessary in smaller spaces.

The 828 cabinet is a hybrid design using a short horn loading the 515 above 150 Hz. Below this it behaves as a reflex cabinet, using both the front and back waves plus room augmentation to get enough efficiency to match the short horn midrange. The result is about 100 dB/W/m down to around 40 Hz. This is very high sensitivity for domestic use, enough to get tons of sound out of a 3 watt amp.

Despite the high sensitivity of the A5 system, Hiraga prefers high power SE amps such as the 30 or 60 watt *Orfeo 845* amps, meaning he gets lower overall distortion, better bass and still has plenty of headroom for dynamics in his large listening room. He brings in the HF horn at 500 Hz with some EQ in the crossover to extend the upper end response to around 16-17 kHz and bring the overall efficiency in line with the bass cabinet.

The 1505B is mounted above the bass cabinet, phase aligned and directed down towards a listener about 12-15 ft away from the speakers. The Altec horn has a fixture which allows the vertical angle of the horn to be changed, permitting you to aim the horn at the listening height and blend it with the bass driver. The horn is not rigidly mounted to the bass cabinet, you can move it to align for best phase response with the bass.

The JBL super tweeter is placed well back on the external rear top of the bass cabinet, also phase aligned and firing at a 45 degree angle into the listening area. This fills the room with the high harmonics and reduces the directionality of the system.

Thanks to the extensive EQ in the crossover, a passive unit designed for use with one amplifier, the sound is very balanced. M. Hiraga changed the port opening on the bass cabinet to better align the reflex cabinet and he uses side mounted bass 'wings' to restore the low bass efficiency for use away from room boundaries. There is some strategically placed damping putty on the mid horn and there is a large thick felt blanket in front of the JBL to prevent reflections off of the cabinet top.

I find the whole assembly attractive in a purposeful industrial design, no nonsense kind of way. My wife has been convinced to live with ours, especially after hearing what they do for music, and a promise from me to clean up the finish a bit. It does take up space, to be sure, but it makes more and better music than any other system I have heard.

Despite the size, it won't go down to 20 Hz, that will have to wait for some kind of serious subwoofer system in the future. The rest of the spectrum reveals how uninvolving and uncommunicative most 'High-End' systems are. Not even taking SE triodes into the equation, this kind of speaker will get the most out of whatever goes in front of it. This is the direction that we need to go.

The Logic of A5 Systems

So, what can we learn from Hiraga's A5 based system?

1) Use high performance, intrinsically linear (i.e. low distortion), high efficiency, drivers and cabinets.

2) Avoid overly extended or resonant cabinet alignments.

3) Use as wide a midrange bandwidth as possible, avoiding crossovers in the 1000 to 3000Hz region. The special qualities of this loudspeaker are in part due to the use of only two drivers for full range response.

4) Phase align and focus the driver alignment.

5) Pay attention to response smoothness over absolute maximum efficiency, 96-100 dB will be enough for virtually any domestic situation even with only a few watts.

6) Make sure the upper harmonic energy is there and can get around the room.

7) Don't worry too much about the lowest octave, especially at the expense of the upper and mid bass performance. The low bass is where the mud starts. And above all, keep it simple.

I will now detail the speaker by addressing each of the above points and discussing specifics of my implementation:

Driver Quality is where everything starts...

The 515 bass driver and 825/828 style cabinet are remarkable for their efficiency, bandwidth and low distortion. I used a 16 ohm 515E driver. This is the ceramic version of the 515B, the legendary Alnico driver.

The 515B and 515E apparently have less midrange output than the new 515G version. This is probably a good thing as there is about a 5 dB step from around 150 Hz up shown in the 515G documentation. This is great when projecting sound in a theater, through a screen, but it definitely needs taming for domestic use.

I personally have no problem with the ceramic version of this driver, the moving

1— According to Altec expert Gary Jones, the early versions of the A5/A7 bass cabinet were called 825, which was replaced by the 828 when the 515 switched from a 15" frame to a 16" frame in the mid-70s. The later woofers will fit in the 825 cabs because the mounting holes are slotted. The early woofers will not fit in the 828.

elements are the same as the 515B version and assuming the gap linearity and flux density is high enough I won't ever have to agonize about whether the Alnico needs to be remagnetized as they sometimes do after time or after a mechanical blow or overload. The 515s are great drivers in any version.

515s have enormous magnets and the 3 inch edge wound aluminum ribbon voice coils are underhung, which greatly increases the driver linearity. The 16 ohm version has a BL factor, which is a measure of the magnetic flux density times the number of turns of wire in the gap, of about 22 for the 515E. Contrast this with a good 8 inch High End woofer BL factor of around 5-8. This is remarkable for any driver and especially impressive in combination with the underhung design mentioned above. This gives an idea of the acceleration potential and the control that this motor system can provide.

The cone is a beautiful paper construction with a very stiff spider. You can push on the edge of the 15 inch cone and there is no rocking, just a linear movement of the whole cone.

The dust cap has a 1 inch hole in the center to avoid compression distortion and dust cap coloration and the damped, pleated suspension avoids the low level hysteresis loss typical of rubber surrounds.

The frame is a masterpiece, with a 1 inch thick edge and massive support beam construction with little area to constrict the back wave flow. The 515E weighs in at a cool 30 pounds. There is really no other way to get the low distortion, high efficiency and impact that the 515 provides.

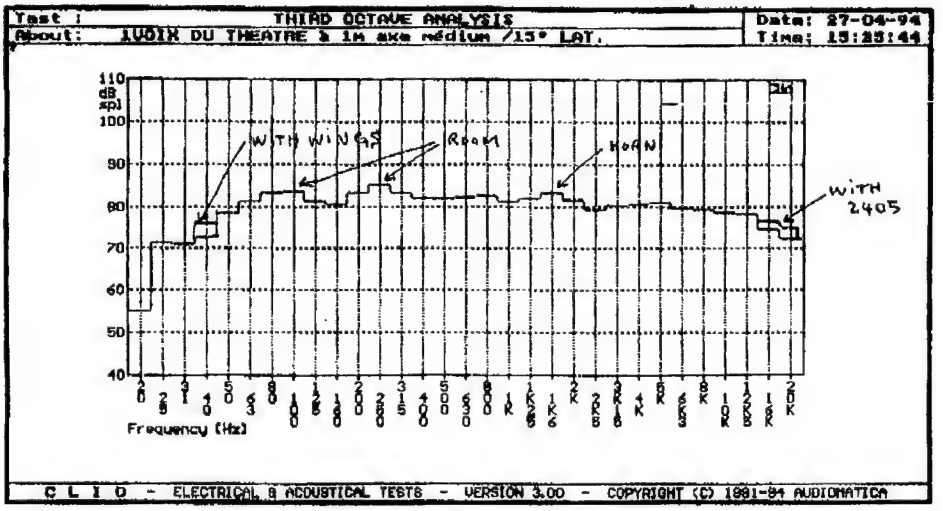
Altec 515s are not mongo PA speakers like many massive pro drivers. Rather, they are delicate instruments which can knock your socks off while they tantalize your subtler senses. They are true high fidelity devices and are rated to handle only about 75 watts of power, no power at all in today's pro speaker universe.

The upper half of the acoustic spectrum is handled by a wonderful driver and horn, the 288K-16 1.4" throat compression driver and the 1505B horn. The version of the 288 that I am using is a newer ceramic magnet 16 ohm unit with the Tangerine precision cast metal phase plug. It goes even higher and cleaner than the older Alnico drivers, making the JBL super tweeter even less necessary.



Above: the A5 system that changed my mind. Jean Hiraga's reference loudspeakers at *La Nouvelle Revue du Son* in Paris

Below: Third octave sweep of frequency response showing contribution of extension "wings" and JBL tweeter.



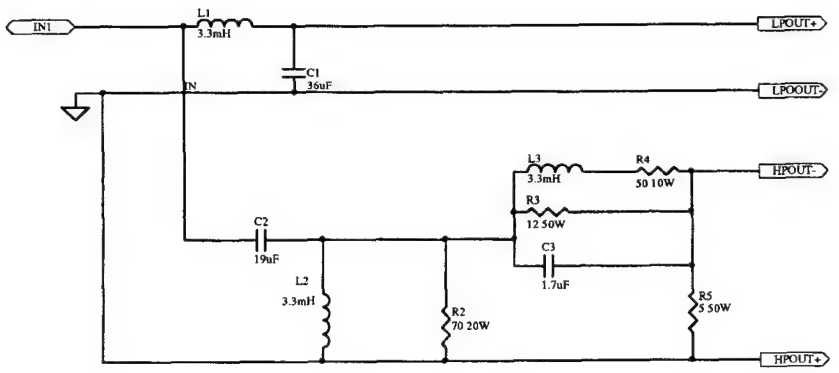
The 288K uses a 2.8 inch diameter concave aluminum alloy dome with integral tangential suspension and edge wound aluminum ribbon voice coil. This "tweeter" weighs 30 pounds giving an idea of the construction quality and magnet size! It has 20,500 gauss flux density in the gap (as much as a Lowther).

The 288K's maximum excursion capability of only 0.035 inches indicates that it is designed to operate without any diaphragm breakup throughout the frequency band and up to very high levels.

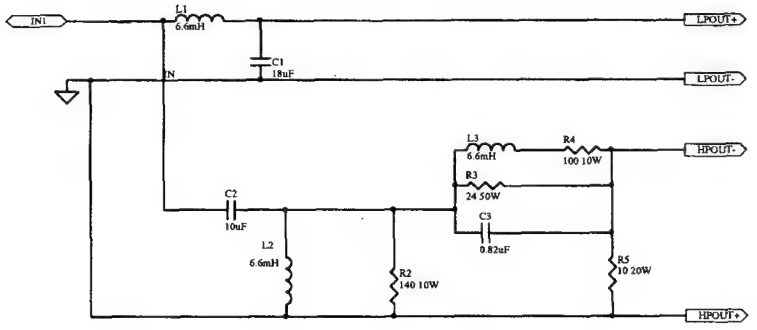
When coupled with a horn like the 1505B it has 112 dB/W/m sensitivity in the 1-5 kHz band! The response drops above this to about 103 dB at 16-17 kHz.

Be sure to pry out the bug screen that these drivers have to protect them in pro use. On the other hand, if you are buying some used you may want to be sure the screens are there if they have been used professionally.

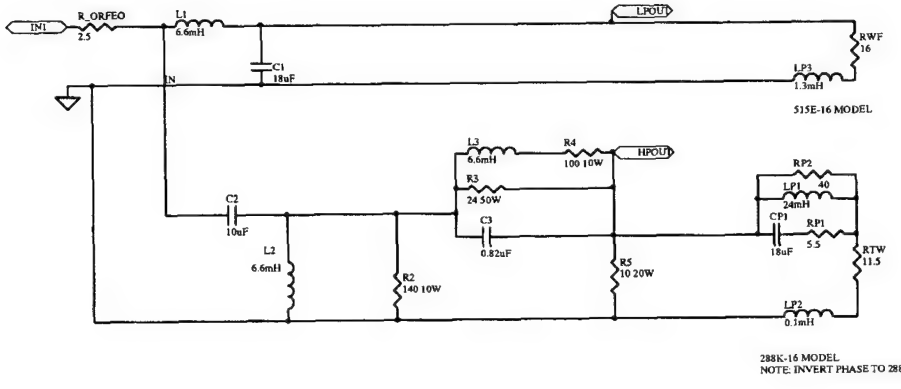
Altec still supplies diaphragms for most of these compression drivers and they can repair, recone and remagnetize most old



Jean Hiraga's crossover for 8 ohm drivers



Crossover component values scaled for 16 ohm drivers from Hiraga's original design



SPICE simulation schematic, including models of 288HF driver, 515 woofer, and simulated output impedance of Orfeo SE 845 amp

cone drivers. The record shows that these puppies can last for over 40 years in auditorium and theater use with virtually no service.

The 288 driver and horn is designed to play at peak levels up to 128-130 dB although its continuous power handling is only around 15 watts. Like the 515 it inhabits a different world from typical "hi-fi" drivers.

Both the low and high frequency horns have controlled directivity with 120 degree horizontal for the high frequency and 90 degree for the low. Both horns have 40 degree vertical dispersion. These dispersion figures mean that they can nicely fill a room but they won't tend to interact as a direct radiator but more like a panel speaker for ceiling and floor reflections.

The very wide dispersion of the 15 cell exponential high frequency horn removes any tendency to beam high frequency energy and cut off your head as many horns can.

The 1505B deserves more description. It is a very large and impressive looking device made from 15 individual exponential horns which come together in a complex assembly having over 3 square feet of radiating area. They are specified for use in theaters with over 400 seats! In my 450 square foot listening room they are barely breathing.

These exponential horns are designed assuming a planar wave launch from the compression driver. It is the job of the phase plug to align the acoustic phase off of the concave diaphragm to approximate a planar wave launch into the driver throat.

The horn really begins with the phase plug. The "Tangerine" plug used in the 288K is a beautifully formed metal piece and allows much of the diaphragm to remain visible through the center of the horn. It appears that the 288 uses about a 2:1 compression ratio through the phase plug. This helps to keep distortion low at high levels and the clear acoustic path helps high frequency extension and clarity.

The 1505B uses long cells to get good low frequency extension with 15 cells in three rows of 5 and a small mouth opening on each cell to get good high frequency extension and dispersion.

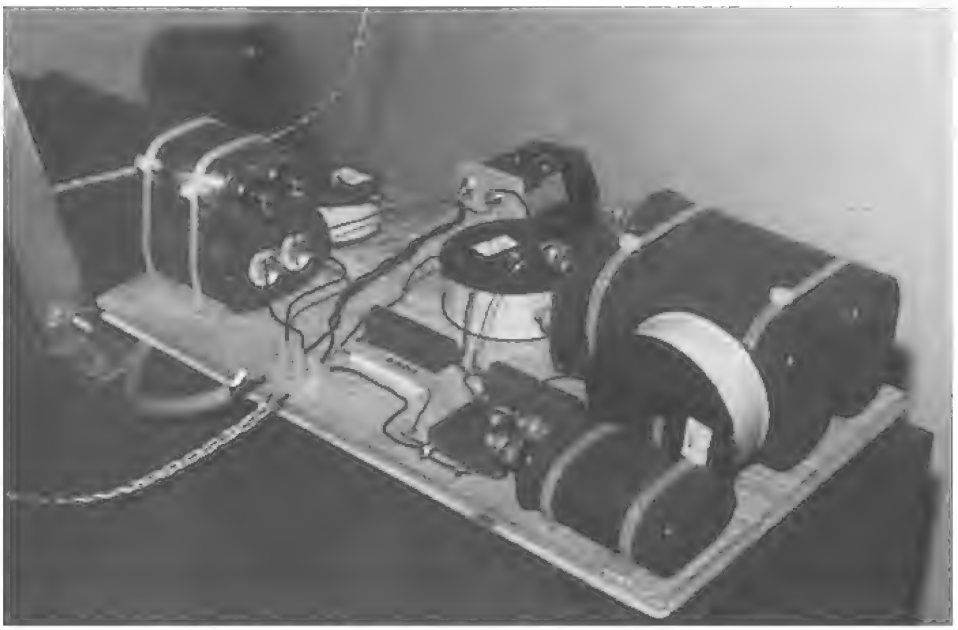
Each individual cell is a hand made aluminum construction with some sort of material like car undercoating used to

dampen any high Q resonances. This is a very effective method and I have had no desire to further dampen this horn.

I hate to think of how much these horns would cost to produce today. They are the only part of this system which cannot be bought off the shelf. If you find some extras, let me know...

I suspect that the enormous mass difference between the moving elements of the 288K and the stationary parts of the 30 pound driver and 30+ pound horn make it doubtful that much energy from the diaphragm goes into resonating these structures. The ability of this combination to reveal natural detailing of harmonic structures and dynamic inflection argues in that direction.

This pair also has the sweetest high frequencies, much like a Maggie ribbon but with much greater impact and dynamic potential.



Constructional Details of Crossover

Make the right tradeoffs in the bass...

The 515 is designed expressly to work in a horn enclosure like the 825/828 cabinet. M. Hiraga has mentioned the golden number ratio when talking about the proportions of this cabinet. These proportions may be why it sounds good even unmodified, with little of the 'boxy' sound that many bass cabinets have. It loads the 515 perfectly, newer ones have the correct volume and port area to allow optimum bass extension and efficiency.

Older ones will need to have the area behind the short horns closed off and the port area reduced by up to 50%. The cabinets that I bought allow some adjustment of the port area and I have set these to the minimum of 25 1/2 by 8 1/4 inches. This port arrangement is near ideal in that the depth of the port is only 5/8", the thickness of the panel. The usual port turbulence and airflow noise is eliminated.

Taken together with the mid-bass short horn and the 1505B HF horn there is about 8.5 square feet of radiating area in each A5. They image and energize a room much like a panel speaker but they have lower distortion, much better efficiency and dynamic capability. There is no troublesome back wave to contend with.

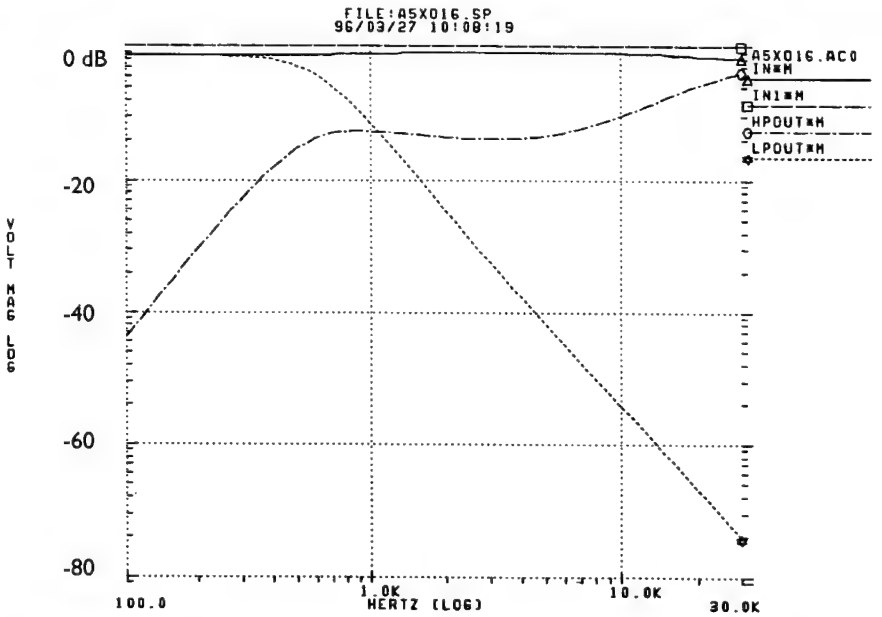
My recent vintage 828 cabinet is well constructed, although it is made of 5/8 inch compressed board. I will be augmenting this with 1/2 or 5/8 inch thick Apple ply, a high quality plywood with thick hardwood ply material. I am going to do this for cosmetic and acoustic reasons.

It has been suggested to inject the area behind the short horn flares with polyurethane insulation material. This sounds like a good idea and should stiffen and dampen the short horn. Although I haven't tried this yet, I don't find much to complain about in the performance that I am getting with the stock boxes.

Make sure that you have a thick bat of fiberglass or other acoustic material on the inside back wall of the enclosure to absorb the back wave at midrange frequencies, the driver is quite close to the back of the enclosure. Don't go overboard here as the low frequencies need to get out of the cabinet or the low frequency extension will be compromised.

If you are looking at older plywood cabinets beware of delamination of the plys as this can be impossible to rectify. Like ceramic magnets, compressed board may not be as sexy but it may be a better overall solution!

I have measured average levels at the listening seat of 100-103 dB when listening



Response of LF, equalized HF driver, and summed response

STANDARD "VOICE OF THE THEATRE" COMPONENT CHART

Model	Amplifier Power (Watts)	Distribution V° H°	L.F. Drivers	H.F. Drivers	H.F. Horn	Throat	Network	L.F. Cabinet	Overall Size – Inches H W D	Approx. Shipping Wt. Lbs.
A1X	200	60 x 125 60 x 105 40 x 100	(6) 515B	(4) 288C	1804B or 1504B or 1004B	(2) 30170 (2) 30170 (2) 30170	N500C	610	113 x 152 x 39½ 113 x 152 x 39½ 105 x 152 x 39½	1530 1500 1475
A1	100	60 x 105 40 x 100	(6) 515B	(2) 288C	1505B or 1005B	(1) 30172 (1) 30170	N500C	610	108½ x 152 x 39½ 102½ x 152 x 39½	1410 1390
A2X	150	60 x 105 40 x 100	(4) 515B	(4) 288C	1504B or 1004B	(2) 30170 (2) 30170	N500C	410	113 x 113 x 39½ 105 x 113 x 39½	1400 1334
A2	80	60 x 105 40 x 100	(4) 515B	(2) 288C	1505B or 1005B	(1) 30172 (1) 30170	N500C	410	108½ x 113 x 39½ 102½ x 113 x 39½	1263 1250
A4X	60	60 x 105 40 x 100	(2) 515B	(2) 288C	1505B or 1005B	(1) 30172 (1) 30170	N500C	210	108½ x 80½ x 39½ 102½ x 80½ x 39½	788 775
A4	40	60 x 105 40 x 100 40 x 80	(2) 515B	(1) 288C	1505B or 1005B or 805B	(1) 30166 (1) 30210 (1) 30162	N500C	210	108½ x 80½ x 39½ 102½ x 80½ x 39½ 102½ x 80½ x 39½	763 750 745
A5X	35	60 x 105 40 x 100 40 x 80	(1) 515B	(1) 288C	1505B or 1005B or 805B	(1) 30166 (1) 30210 (1) 30162	N500C	825B	64 x 30½ x 30 59 x 30 x 27 59 x 30 x 27	393 280 275
A7-8	50	40 x 90	(1) 416-8A	(1) 807-8A	811B	None	N801-8A	825B	52½ x 30 x 24	154
A7-500-8	50	40 x 90	(1) 416-8A	(1) 808-8A	511B	None	N501-8A	825B	54½ x 30 x 24	160
A8	30	60 x 90	(1) 416A	(1) 806A	30623	None	N800D	39624	42 x 30 x 12	112

to some recent Clapton (he sounds like he's fronting a great bar band...). At this level, with plenty of drum and bass energy and peaks of 110 to 115 dB, the 515 drivers are barely moving! This is a direct indication of the low distortion level that this system has under even extreme conditions. Most woofers would be moving up to 1/2 inch at these kinds of levels. This system is not even moving 1/8 inch peak to peak – well within the linear range of the driver.

Like the 1505B, the short horn in the 825/828 enclosure is inherently pleasing to look at and I would recommend leaving it open to the world. I suspect that a clear finish on light birch ply would complement the neutral gray of later 828 cabinets. I am going to make a simple hardwood foot assembly to support the 1505B and the 288 driver assembly. Typically they are mounted with 4 inch long L brackets and the adjustable rear support leg to a piece of 'vulgar' painted plywood, as my wife calls it. A more elegant T shaped construction with three cones for support would bring the 1505 somewhat lower and also provide some worthwhile mechanical isolation from bass cabinet energy.

The crossover brings the system together...

If I did not have M. Hiraga's valuable input into the crossover design I would have been much more concerned about the outcome of this experiment. As it happens, his 10-20 years of experience with this type of system and his insight into how to knit the system together nearly guaranteed some level of success.

His original network shown above is for 8 ohm drivers. I scaled the values for the 16 ohm versions and added R5 to match levels. The complete crossover schematic is shown on p. 8.

I simulated the schematic using SPICE, a program that I use for Integrated Circuit (IC) design. It uses complex matrix equations to solve the nodal values for the circuit and is quite accurate if your model is accurate. The complete simulation schematic is provided on p. 8, including models I developed to simulate the non-linear impedances of the loaded drivers and I have added a 2.5 ohm resistor to simulate the output impedance of a typical SE triode amp driving this network.

L1 and C1 make up a 2nd order butterworth low pass network at 500 Hz for the 515 driver. It is quite simple and classic. For now I have a 500 watt rated ferrite core inductor with less than 0.5 ohm DCR and I used high power 660VAC rated oil filled polypropylene and paper capacitors for the low pass section (GE type 97F41XX). The idea is to be sure that the crossover components are stressed as little as the drivers in typical use.

The high frequency section is more complex with a basic high pass 2nd order section consisting of L2 and C2. I used an air core coil and 10 kHz rated low inductance, high power, oil filled caps for this section (GE type 97F85XX). R2 controls the maximum Q of the inductor and dampens transient overshoot energy, having little effect on the steady state frequency response. L3, and C3 along with R3, R4 and R5 make up a resonant trap with controlled Q and attenuation to equalize the 112 dB midband response of the 288 driver down to 100 dB and to allow it to go to 16 kHz with little attenuation.

The resulting response of this network into the simulated driver impedances is shown on page 9 above. Note that there is about 12 dB (over 4X voltage or 10X power) attenuation from 1-5 kHz with the response above and below this region allowed to rise as the natural rolloffs of the driver/horn take over. Again, L3 is an air core coil and C3 is a 19 kHz rated oil filled cap which are totally unstressed in this application.

The off the shelf cost of these components is more than a manufacturer would put in an entire $1500 pair of speakers, let alone a crossover network. I probably will replace L1 in the woofer circuit with a copper ribbon or some other exotic inductor as it is likely the limiting element in the implementation. All resistors are 50 watt rated wire wound aluminum cased units. You could give some range to R5 for a treble level control. I would suggest a 5 to 20 ohm range, this would give you several dB of adjustment without affecting the crossover frequencies. Use a good quality 20 watt single turn wire wound rheostat with a fixed resistor in series for an adjustable R5.

It is very instructive to listen to each driver alone through the crossover. Each frequency section sounds so very different that you wonder how the mushy low end and tinny high end can come together to make music. I believe that the 500 Hz crossover point is an ideal place for a crossover, as the Fletcher Munson curves show that the ear's operation changes at this point, acting differently above and below this frequency band. It seems a natural point to divide the spectrum. Listening tests bear this out.

Phase align the Bass and Mid drivers...

The separate 1505B horn allows you to move the upper frequency driver to align it with the bass and focus the energy toward your listening area. This is similar to what Wilson does with his larger systems and gives great flexibility in system setup and optimization.

I am using the speakers only about 8 inches from the back wall with the cabinets toed in so that the center is around 10-11 inches from the back and about 55 inches from the side walls. They image fine in this position and the Bestplace software available off the net from RDL Acoustics shows about 6-8 dB of room gain at 40 Hz. If used in a larger room, farther from room boundaries, you will need to add the wings to extend the last octave or so to get 40 Hz response. Putting them nearer to the back wall is great because it reduces the physical impact relative to smaller free standing speakers and the controlled directivity above 150 Hz means that imaging does not suffer at all. If they are too close to the back wall there will be too much mid bass energy.

I found that moving them only a few inches can make a real difference in how they load the room. My room is probably about as small as you would want to go with these and it is about 19 x 23 x 8 1/2 feet. This lets me put them 11 feet apart with a listening position 13-15 feet away. In this setup they have a remarkable ability to disappear acoustically and images can occur between, behind, and beyond them, as the recorded material allows.

When I align the HF horn I use a flashlight to make sure that I can see the diaphragm through the center horn from the listening chair. Then I move the horn forward and back relative to the bass driver while listening to a good female vocal to get the smoothest response through the crossover region. Movements as small as 1/8 inch can be audible.

Why doesn't the stock crossover work in this type of speaker?

That is really quite simple. For theater use the crossover is designed to be as lossless as possible, efficiency is everything when trying to fill a large space with intelligible speech and music.

	515	515B	515C	515E	515-8LF	515-8LFE	515-8G	515-16G	515-8GH
Power	35W	75W	75W	75W	125W	125W	75W	75W	200W
Response*	55-1000Hz	55-1000	55-1000	45-1000	45-1500	45-1000	50-4000	55-4000	60-4000
X-over	500	500	500	500	500	500	2,500	2,500	2,500
Sens.**		105 dB	105 dB	105 dB	105 dB	105 dB	105 dB	106 dB	106.5 dB
Z	16 Ohms	16 Ohms	16 Ohms	16 Ohms	8 Ohms	8 Ohms	8 Ohms	16 Ohms	8 Ohms
Fs	25Hz	25Hz	25Hz	25Hz	25Hz	25Hz	37Hz	37Hz	37Hz
Magnet	Alnico	Alnico	Alnico	Ferrite	Alnico	Ferrite	Ferrite	Ferrite	Ferrite
Flux		1.4750 T	1.4750 T	1.3T	1.4750 T	1.3T	1.5T	1.5T	1.5T
Frame	15"	15"***	16"	16"	16"	16"	16"	16"	16"

Notes: *Frequency response corrected to indicate 3dB down points for all models
**Sensitivity measurements corrected to 1W/1M rating
***515B manufactured after July 1977 had 16" frames

Altec 515 LF Driver Revision History

In a small room for music listening you need at least 12 dB of HF attenuation and you can let the higher harmonics come in better. These horns sound remarkably sweet in the upper frequencies and can even seem overly soft until some real HF energy comes in and startles you with its presence and detail. When EQed correctly, they have a very natural bloom and energy with very low distortion giving a sweet yet detailed sound.

Distortion of this speaker above 100 Hz at 100 dB out will be typically less than 0.05%! This level of distortion is even less than that provided by the 30 watt *Orfeo* amp which is around 0.07% at 1 watt out. I would guess that most people have never heard a loudspeaker with as low distortion as these. This contributes greatly to the naturally detailed sound and dynamics that approach those of live music.

Upper frequency energy is very important to living, breathing music.

Most (virtually all) dome tweeters are totally anemic in presenting upper frequency energy. They lack the bloom and subjective power that is needed to fill out the harmonic structures in music. They also tend to pinch the sound and lack dynamic headroom. The 288/1505B combination allows these frequencies to fill the room with ambiance and harmonic detail that otherwise I have only heard live.

These speakers will not impress your friends with ultra low frequency energy and sensaround experiences.

They will play a cello, timpani and string bass better than you have heard them before with tremendous midbass presence from the short horn and excellent, resonance free bass. If this can't impress your friends, get new ones! I hope that you can hear what a system like this can do. It's worth it.

Addendum

I have just read a recent article in the *Journal of the Audio Engineering Society* (Vol. 44, No. 1/2, 1996 January/February) which throws some light on why the 1505B sounds so much better than other mid horns in my experience. This article titled 'The Sound of Midrange Horns for Studio Monitors' should be required reading. It describes a very well constructed test to compare the sound of midrange horns from 1kHz to 4kHz with several references. These references are the old QUAD electrostatic which is a long time reference for subjective midrange quality, an Audax (Polydax) 6 1/2 inch pro quality cone driver and two horn coupled mids including a large sectoral Fostex and a Tannoy. These references are compared to 14 different horn mids and a couple of cone control drivers. This article could be a model for scientifically valid subjective testing. Care was taken to choose test material and test methodology to avoid listener fatigue and stress and to insure valid results which correlate to listening to music. The authors' approach is much more sophisticated than the ABX method which some have tried to force on the industry.

Anyway, the results showed that there is a horn 'sound' with most mid horns. There were, however, two horns which were never identified as being horns in the blind testing. One is a prototype short horn with a medium mouth opening and a length of only 230mm. The other horn is an old ALTEC 806C 8 cell multicell which is a smaller version of the 1505B with the same basic construction and fewer individual cells.



There are two keys to these horns' performance. The short horn length on the one means that any mouth reflections occur in a short time span and are subjectively innocuous. On the long ALTEC horn the mouth area is large enough, compared to the cutoff frequency, that the mouth reflections are a small fraction of a dB.

The second key to the subjective sound quality is that these horns are designed to have no abrupt flare rate changes along their lengths from the phase plug to the mouth opening. Any flare rate discontinuity causes high frequency reflections which cause spectral colorations and problems in the upper mids and high frequencies. Neither of these horns have flare rate discontinuities when used with the right compression drivers.

Indeed, the ALTEC multicell horn was thought to sound most like the QUAD electrostat. It was not identified as a horn speaker by any of the listeners, including a 'Golden Eared' pro who was among the test subjects. It seems that this old design was very well thought out when it was done originally for cinema use in the 30s and 40s.

I also suggest that you seek out Harry F. Olson's 1947 book *Elements of Acoustical Engineering*. Page 106, section 5.24 has an excellent discussion of the mouth reflection effects of a horn and shows clearly why a large mouthed long horn will sound better, avoiding the 'horn' sound problem that shows up with many small midrange horns. The solution to mid horn sound problems was clearly known back then, they knew more than we have forgotten.

Special thanks to Jean Hiraga for sharing his research with the audio community.

Thanks also to Jim Long and Gary Jones of the Mark IV Audio North America pro sound team.

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EXEMPLAR

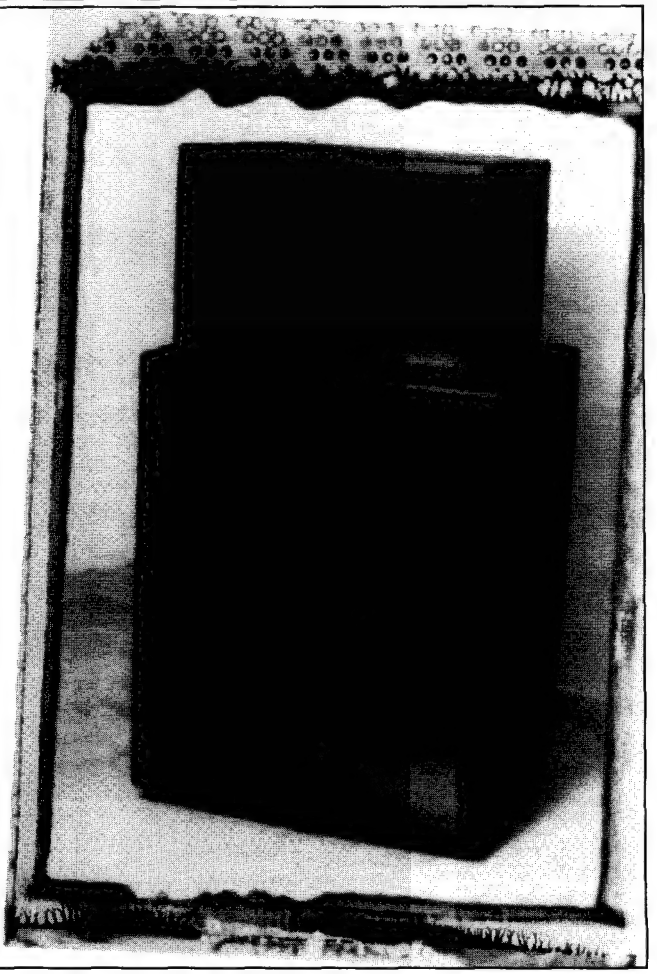
THE MUSIC LOVER'S
HORN SPEAKER SYSTEM

Integrating the best in performance and sonics through tractrix horn loading, optimized bass reflex, professional quality drivers and premium quality passive components.

Designed to complement low power amplification, offering you:

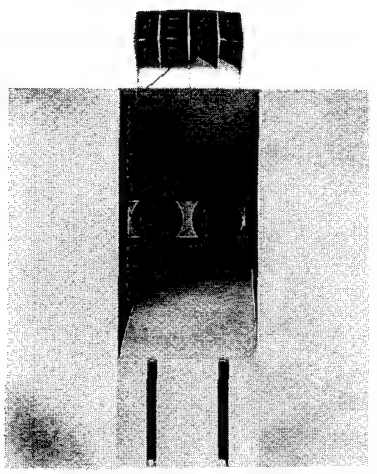
- Balance from the deep bass through the upper treble
- Realism through abundant detail and dynamics
- Efficiency and effortless presentation
- Emotional impact

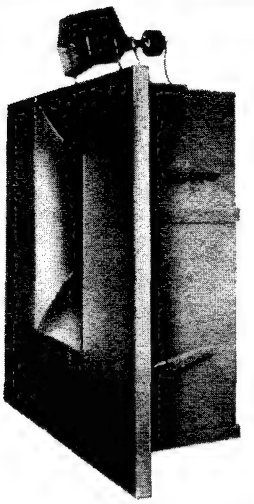
Triode Support Systems
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Low Frequency Horns

L-F HORNS





210 Horn with speakers installed

Features

Direct Radiating

Rugged Construction

Authentic Bass Reproduction

Exponential Expansion

Wide Distribution

Exceptional Air Coupling

Uniform Response

Variety of Sizes

Efficient Bass Projection

For High Quality, Two-Way Sound Systems In . . .
Theatres • Auditoriums • Arenas • Churches
Concert Halls • Audition Rooms

Altec "Voice Of The Theatre" speaker systems are used in more than 12,000 motion picture theatres, auditoriums, arenas and other sound reinforcement installations throughout the world. An important component of each such system is an Altec Low Frequency Horn.

These large low frequency horns ensure proper loading which effects excellent air coupling and enhances the performance of the low frequency loudspeakers. Exponential expansion, properly spatial phased with the high frequency horn, assists the projection of the important mid-range frequencies.

Front loaded in design, Altec Low Frequency Horns have no folds or bends to introduce 'holes' or 'hot spots' in the sound coverage. The elimination of any irregularities assures a uniform response across the dispersion angle of the horn, a factor essential in the calculation of sound systems. The combination bass reflex/front loaded design prevents the boom and false accentuation often associated with public address systems which use other types of enclosures, reduces the amplitude of cone movement at resonant frequencies, and allows higher power input without distortion. The efficient use of the lower end of the sound spectrum contributes to the illusion of loudness and presence required to distinguish the outstanding Altec "Voice Of The Theatre" system from ordinary loudspeaker systems. For installations where the 210 and 410 horns are used on the floor, the use of wings will further improve the bass projection.

Altec Low Frequency Horns are carefully constructed with heavy materials and braced where acoustically required to exclude unwanted vibrations. The sturdiness of these horns permit them to be mounted in walls and ceilings of auditoriums, or to be suspended overhead in large areas. All horns are finished with a flat finish, dark grey, instrument lacquer. Where the horns are to be used in outdoor installations, a weatherproof coating of resin may be applied without impairment of their performance.

These horns are designed for use with either the Altec 416A or 515B Low Frequency loudspeakers. They should be used in conjunction with high frequency horns (multicellular or sectoral) and high frequency drivers for a full range, two-way system (see Table II).

ALTEC LANSING

A Division of LTV Ling Altec, Inc.

1515 S. Manchester Ave., Anaheim, Calif.
New York

1966 ALTEC Engineering Specifications

ALTEC L-F HORNS

TABLE I: SPECIFICATIONS

Horn Model Number (A)	Number of Low Frequency Speakers Per Horn (B)	DIMENSIONS (C)				Weight (Without Wings) (D)
		Height	Width		Depth	
			With Wings	Without Wings		
210	2	84"	80½"	32½"	39½"	560 lbs.
211*	2	32½"	(Not Used)	84"	39½"	560 lbs.
410	4	84"	103"	65"	39½"	890 lbs.
825	1	42"	(Not Used)	30"	24"	100 lbs.

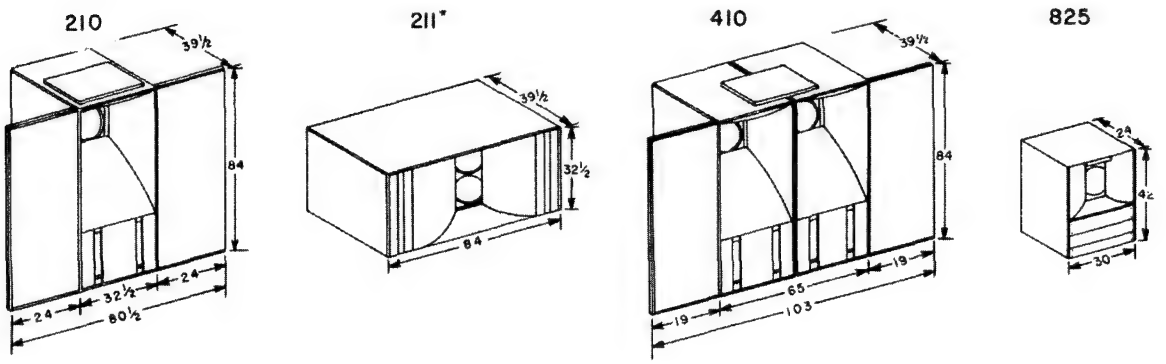


FIGURE 1: Dimensional Drawings of Altec Low Frequency Horns
*Available on special order only

TABLE II: Recommended Components for Complete Systems

LF Horn	Power (Watts)	HF Drivers	LF Drivers	HF Horn No.	Distribution	Throat	Network (16 ohm)	Overall Size H W D	Approx. Shipping Weight
410	150	4 — 288C	4 — 515B	1804B, 1504B, 1004B	60° x 125° 60° x 105° 40° x 100°	2-30170 2-30170 2-30170	N500C	113" x 120" x 39½" 113" x 120" x 39½" 105" x 120" x 39½"	1400
410	80	2 — 288C	4 — 515B	1505B, 1005B	60° x 105° 40° x 100°	1-30172 1-30170	N500C	108½" x 120" x 39½" 102½" x 120" x 39½"	1250
210	60	2 — 288C	2 — 515B	1505B, 1005B	60° x 105° 40° x 100°	1-30172 1-30170	N500C	108½" x 80½" x 39½" 102½" x 80½" x 39½"	775
210	40	1 — 288C	2 — 515B	1505B, 1005B, 805B	60° x 105° 40° x 100° 40° x 80°	1-30166 1-30210 1-30162	N500C	108½" x 80½" x 39½" 102½" x 80½" x 39½" 102½" x 80½" x 39½"	750
825	35	1 — 288C	1 — 515B	1505B, 1005B, 805B	60° x 105° 40° x 100° 40° x 80°	1-30166 1-30210 1-30162	N500C	64" x 30½" x 30" 59" x 30" x 27" 59" x 30" x 27"	275
825	30	1 — 806A	1 — 416A	811B	40° x 90°	None	N800D	54" x 30" x 24"	200
825	30	1 — 806A	1 — 416A	511B	40° x 90°	None	N500E	54" x 30" x 24"	200

NOTICE

We recommend that you obtain your Altec products from factory trained authorized Altec Sound Contractors and Distributors. This will assure you of proper installation, a continuing source of knowledgeable advice, service, and quick warranty protection.

ARCHITECTS AND ENGINEERS SPECIFICATIONS

The low frequency horn shall be of the direct radiating type with an enclosure of combined bass reflex/front loaded type. It shall consist of a short exponential horn designed to match the phasing of the high frequency horn specified elsewhere. Horns which employ folds or bends will not be acceptable under this specification because of their tendency toward frequency cancellation.

The horn shall measure (C) and weigh approximately (D). It shall be of heavy plywood and shall be fully braced with 2" x 3", and 2" x 4" frames. It shall be designed to mount and properly load (B) low frequency speakers of the type specified elsewhere.

Any low frequency horn not meeting these requirements shall not be acceptable under this specification.

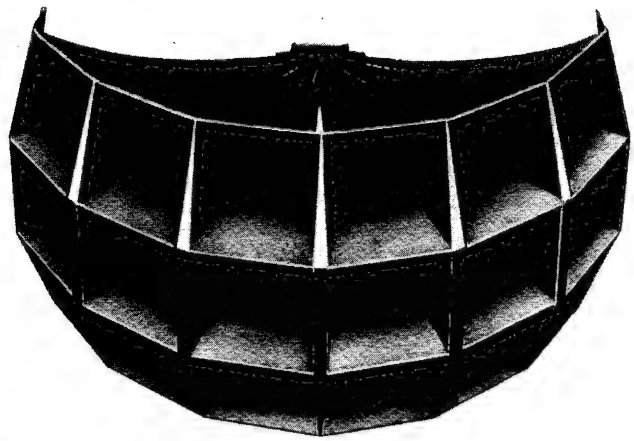
The low frequency horn shall be Altec Lansing Model (A).

Litho in USA C/P 3/66

AL-1435-3

© Altec Lansing

Multicellular Horns



AUDITORIUMS • STADIUMS • ARENAS • THEATRES • AIRPORT TERMINALS
OUTDOOR VOICE WARNING SYSTEMS • INDUSTRIAL AND COMMERCIAL INSTALLATIONS

The exponential multicellular horn is the most efficient of all projectors for delivering top quality sound uniformly over a defined listening area. The unique excellence of the multicellular horn results from its distinctive design:

(a) The multicellular horn consists of a number of individual horns assembled in various configurations to provide controlled angles of vertical and horizontal distribution for best sound coverage of any listening area.

(b) Each horn or cell of the multicellular horn is a straight exponential trumpet through which sound can pass unimpeded. This is a distinct advantage over horns of the re-entrant or reflex type which severely attenuate the high frequencies and cause distortion due to sharp folds or bends in the sound passage.

(c) The column speaker exercises control of sound only in the vertical plane, whereas the multicellular horn controls sound in both the vertical and horizontal planes thus providing the added advantage of restricting sound projection into reverberant side walls.

(d) The re-entrant or reflex horn and the column speaker are handicapped by the fact that the beam width becomes steadily narrower as frequency increases, to a point where sound coverage in the critical high frequency range between 2,000 and 10,000 cycles shrinks to a narrow pencil of sound, in some cases only 15° to 30° wide.
In contrast, the beam width of the multicellular horn above the cross-over region and in the important mid- and high-frequency regions to 12,000 cycles and beyond, is independent of frequency. This entire portion of the frequency spectrum is uniformly distributed throughout the full angle of the horn.

(e) The multicellular horn with its great undistorted power handling capacity (up to 400 watts) is unequaled by any other commercially available sound projector for distribution of highest quality sound over large outdoor areas.

Altec multicellular horns will accommodate as many as four drivers of the 288C type for indoor use, or 730B and 290D type for outdoor use. The latter drivers and the 30546 angle adaptor in combination with a multicell horn constitutes a complete All-Weather system.

The multicellular horn was developed by the Bell Telephone Laboratories of a necessity to insure the success of early talking pictures. Ordinary horns proved incapable of providing good quality coverage to every seat in large theatres, most of which were far from ideal acoustically. The folded horn was discarded in theatre work in 1934 and since that time the multicellular horn has remained the standard of excellence.

The 300 cycle cutoff multicellular horn is often used as a "one-way" speaker where voice only is to be reproduced, or where maximum intelligibility is required to penetrate high ambient noise levels, or for projection over long outdoor distances. The 500 cycle multicellular horn with a 500 cycle crossover network and low frequency speakers, Altec 416A or 515B, are generally used for full range "two-way" loudspeaker systems such as Altec "Voice of the Theatre" systems for the reproduction of high quality voice and music.

PERFORMANCE AND SPECIFICATION DATA ON BACK PAGE

ALTEC LANSING

A Division of LTV Ling Altec, Inc.

1515 S. Manchester Ave., Anaheim, Calif.

New York

MULTICELLULAR HORN PERFORMANCE CHART

Horn Model Number* (a)	Quantity of Drivers Used per Horn (b)	Driver Model Number (c)	Sound Pressure Level Full Power Each Driver** Measured at 30 feet (d)	Sound Pressure Level Full Power Each Driver** Measured at 100 feet (d)	Distribution Pattern (e)	Cutoff Frequency (f)	Cell Configuration	Throat Code Number ***
203B	1	288C	118 db	108 db	20° x 40°	300 cps	1 x 2	(not required)
		290D	121 db	111 db				
		730B	114 db	104 db				
803B	1	288C	115 db	105 db	35° x 70°	300 cps	2 x 4	30162
		290D	118 db	108 db				
		730B	111 db	101 db				
804B	2	288C	118 db	108 db	35° x 70°	400 cps	2 x 4	30172
		290D	121 db	111 db				
		730B	114 db	104 db				
805B	1	288C	113 db	103 db	40° x 80°	500 cps	2 x 4	30162
		290D	116 db	106 db				
		730B	109 db	99 db				
1003B	1	288C	113 db	103 db	35° x 90°	300 cps	2 x 5	30210
		290D	116 db	106 db				
		730B	109 db	99 db				
1003B	2	288C	116 db	106 db	35° x 90°	300 cps	2 x 5	30170
		290D	119 db	109 db				
		730B	112 db	102 db				
1004B	4	288C	119 db	109 db	40° x 100°	400 cps	2 x 5	(2) 30170****
		290D	122 db	112 db				
		730B	115 db	105 db				
1005B	1	288C	112 db	102 db	40° x 100°	500 cps	2 x 5	30210
		290D	115 db	105 db				
		730B	108 db	98 db				
1005B	2	288C	115 db	105 db	40° x 100°	500 cps	2 x 5	30170
		290D	118 db	108 db				
		730B	111 db	101 db				
1504B	4	288C	118 db	108 db	60° x 105°	400 cps	3 x 5	(2) 30170****
		290D	121 db	111 db				
		730B	114 db	104 db				
1505B	1	288C	110 db	100 db	60° x 105°	500 cps	3 x 5	30166
		290D	113 db	103 db				
		730B	106 db	96 db				
1505B	2	288C	113 db	103 db	60° x 105°	500 cps	3 x 5	30172
		290D	116 db	106 db				
		730B	109 db	99 db				
1803B	1	288C	110 db	100 db	53° x 105°	300 cps	3 x 6	30166
		290D	113 db	103 db				
		703B	106 db	96 db				
1803B	2	288C	113 db	103 db	53° x 105°	300 cps	3 x 6	30172
		290D	116 db	106 db				
		730B	109 db	99 db				
1804B	4	288C	116 db	106 db	60° x 125°	400 cps	3 x 6	(2) 30170****
		290D	119 db	109 db				
		730B	112 db	102 db				

* Model code denotes number of cells and horn cutoff frequency. Example: 1504B = a 15 cell horn (3 rows of 5 cells per row) with cutoff frequency of 400 cps.

** Sound Pressure Level (SPL) as shown in column (d) above is based or measured at 30 and 100 feet with full rated power applied to each driver as shown in column (b) and averaged uniformly over 600 to 2,400 cps. (see note 1.)

*** One 30474 Adapter required in addition to indicated throat for each 730B Driver used.

**** If only two drivers are desired on the 400-cycle horn, use two 30210 single throats in place of two 30170 double throats.

NOTE 1. Full power rating on
288C is 40 watts
290D is 100 watts
730B is 60 watts

NOTE 2. Driver units should be protected against low frequency by use of N500C Altec Network, or the 15045A Line Transformer.

NOTE 3. It is recommended that 30546 45-degree angle adapters be added to each driver for added weather protection in all outdoor installations.

NOTE 4. Sound Pressure Level Conversion Table

I) To increase SPL 3 db double the input power; to increase 6 db, quadruple the input power.

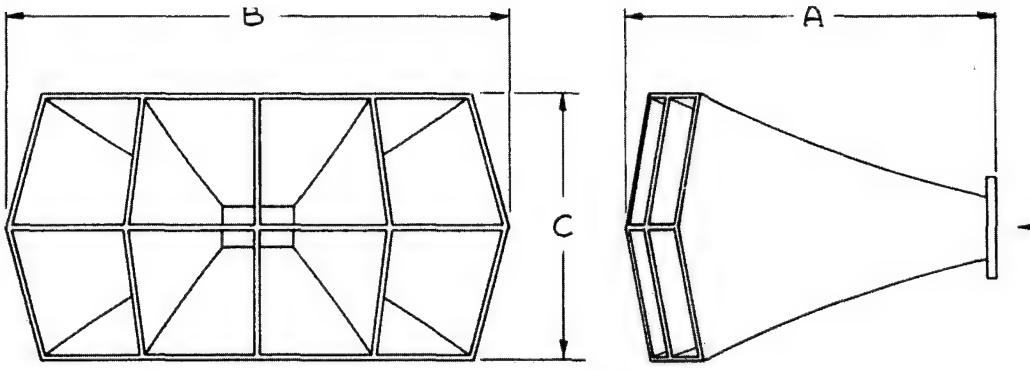
II) Each time distance of horn projection is doubled substract 6 db SPL.

ARCHITECTS AND ENGINEERS SPECIFICATIONS

The high-frequency horn shall be of the multicellular type, equipped with proper throat and adapters and (b) (c) compression driver or transducer. As specified elsewhere, it shall produce a uniform sound pressure field of (d) db at a distance of (select from d) feet with (Note 1) watts input power applied to each driver over a field of distribution of (e) uniformly averaged over the band of 600 to 2,400 cps. Single frequency measurements will not be acceptable under this specification. The low-frequency cutoff shall be (f) cps.

The horn shall be constructed of individual weatherproofed metal cells with a special damping material coating the external surfaces of each cell. The cells shall all be straight with an exponential expansion. Folded or re-entrant horns or horns fabricated of wood or other fiberous materials will not be acceptable. The horn shall be equipped with mounting brackets or facilities both on the front or mouth and on the appropriate cast throat. Multicellular horn shall be Altec Lansing Model (a).
(Note: Fill in proper values and numbers from Horn Performance Chart.)

© Altec Lansing 5/65



Multicellular Horns

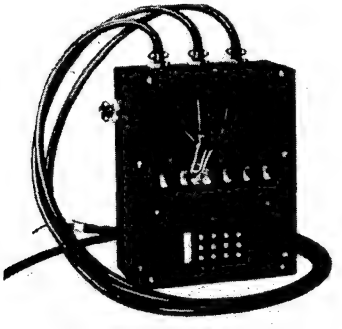
HOW TO SELECT THE CORRECT MULTICELLULAR HORN FOR SPECIFIC AREA COVERAGE

Multicellular projectors are available in several configurations. The sound distribution pattern (angle) is determined by the cell arrangement. Each cell of a 500 cycle horn projects sound over an area of 20° square, or 400 square degrees per cell; a 400 cycle horn distributes sound over an area of 19° square per cell and a 300 cycle horn over an area of 17-1/2° square per cell (203B horn - 20° square per cell). The sound distribution pattern, both horizontal and vertical, of a horn, is established by the total number of cells assembled in each plane.

Determine the area to be covered and, by reference to the chart on page 4 of this bulletin, select the horn having a distribution pattern which will most closely cover this area. To obtain full advantage of controlled distribution, no greater area of sound coverage should be provided than can be effectively used. Multicellular horns are composed of a group or stack of individual horns so that each small horn becomes a component part of the large horn assembly. All cells are fed from a common throat.

The partial spherical front achieved by grouping the cells allows each cell to contribute to the whole without overlap or confusion. In installations where speech only is to be projected, the projection ability of a 300 cycle horn can be increased by sharply cutting off the low frequency energy fed the horn an octave above the rated cutoff of the horn by use of an Altec N-500C network or the 15045A 70-volt line transformer. In this manner, the horn has an effective length considerably greater than its physical length. By selection of the proper cell configuration, the projected sound is fully controlled in both the vertical and horizontal plane and this feature proves useful in combating high reverberation and in minimizing or eliminating acoustic feedback. A 300 cycle horn in combination with a 500 cycle crossover network, will greatly aid in overcoming objectionable reverberation by giving the horn greater projection ability by restricting the radiation of the low frequencies, which are often undesirable in the masking of sound and contribute little or nothing to speech intelligibility.

Accessories



N-500C Dividing Network Set



15045A 70-Volt Line Transformer



30546 45° weatherproof throat adapter

30162 horn throat (single unit)

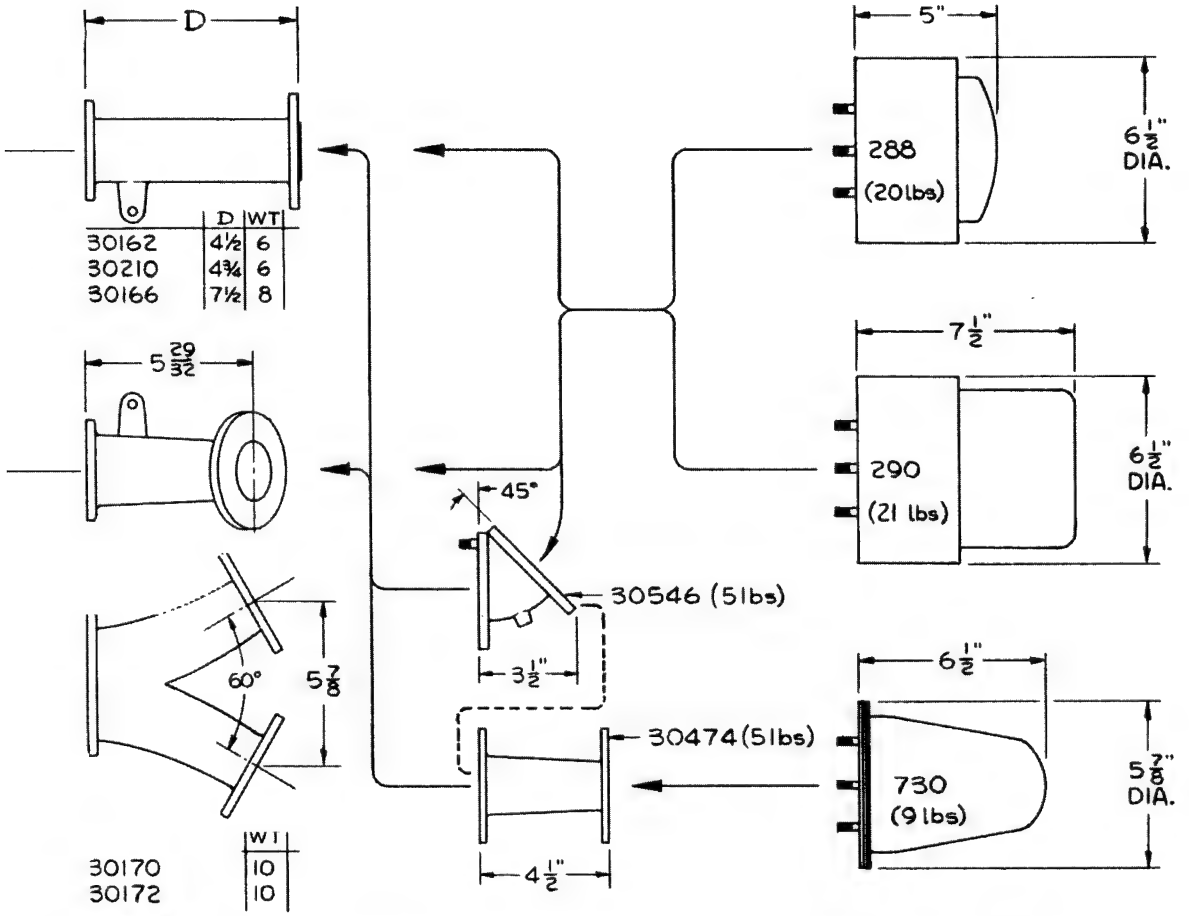
30210 horn throat (single unit)

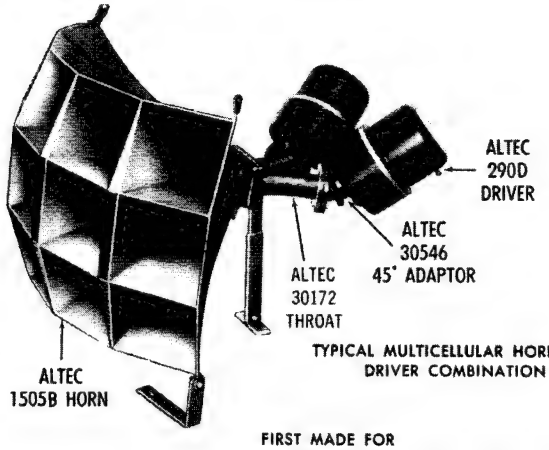
30166 horn throat (single unit)

30170 horn throat (double unit)

30172 horn throat (double unit)

30474 adapter





TYPICAL MULTICELLULAR HORN AND DRIVER COMBINATION

HORN	A	B	C	WT.
203B	31	32	17	22
803B	26 1/2	32	16 1/4	27
804B	23 1/2	32	16 1/4	25
805B	17 1/2	24 1/2	13	17
1003B	25 1/2	38	16 1/8	32
1004B	*20 1/2	38 1/2	16 1/4	30
1005B	17 1/4	30	13	20
1504B	*21	38 3/4	24	48
1505B	16 3/4	30 1/2	18 1/2	22
1803B	27 1/2	44	24	60
1804B	*23 1/2	44	24	58

*(Add 4" for throat adapter)
(Furnished)

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A Hardwire Technique for Tube Circuits

by Ron Sawyer

Order out of chaos

Hardwire circuit assembly techniques offer several advantages for the Do-It-Yourselfer who is constructing a one or two of a kind vacuum tube audio project. In addition to eliminating the need to design and fabricate an etched circuit board, hardwire assembly can result in superior ventilation of components and also excellent serviceability, including the ability to make radical modifications.

Photo number 1 is hardwire hell, an excellent example of how not to construct a circuit. Not only poor in appearance, this type of assembly is difficult to service and/or modify. In contrast, Tektronix tube-type instruments are superb examples of a well evolved hardwire technique.

A detail from a Tektronix power supply is shown in photo number 2. The Tektronix factory utilized ceramic terminal strips to support passive components near the associated tubes. We can use readily available edgeboard connectors as terminal strips to emulate the Tektronix style of construction.

Photo 3 shows a selection of edgeboard connectors compared to old style fiber terminal strips. The longest of the edgeboard connectors is shown with threaded aluminum spacers installed as a means of mounting the connector to the chassis. The solder eyelets will be used as the tie-points of the circuit as illustrated in the subsequent photo-demonstration.

The edgeboard connectors are most commonly available with two electrically isolated rows of contacts of which the constructor may utilize one or both depending on circuit complexity. The connectors are available with as few as 6 positions/12 contacts per unit to as many as 43 positions/86 contacts; the larger connectors are more economical on a per terminal basis.

I found that connectors with .156" spacing between terminals are most appropriate for accommodating the larger resistors and capacitors often used in tube circuits as the solder eyelets are bigger and sturdier than those found on the edgeboard connectors with .100" or .125" spacing. For the remainder of this article I will refer to the edgeboard connectors as terminal strips.

The first step is to plan out the wiring scheme of the circuit you wish to construct. Figure 1 is a schematic for a simple line-level voltage amplifier with a direct-coupled cathode follower and Figure 2 is a drawing of the wiring plan. Although layout is not generally critical in this type of audio circuitry, you should try to orient the tube socket to allow for direct and tidy wiring. Low level/high gain amplifiers do require more care in layout and you should try to isolate, as much as practical, the input circuits from the output. You should make a life-size drawing for your plan, and try to have on hand the actual components you will be using.

In Figure 2, I chose a 1.6" spacing between the two rows of terminal strips; this distance may be altered depending on the size of the components you are using.

I like to generously derate (by a minimum of 400%) the resistors I use; if one is going



Photo 1—Typical old-fashioned consumer grade hardwire hell

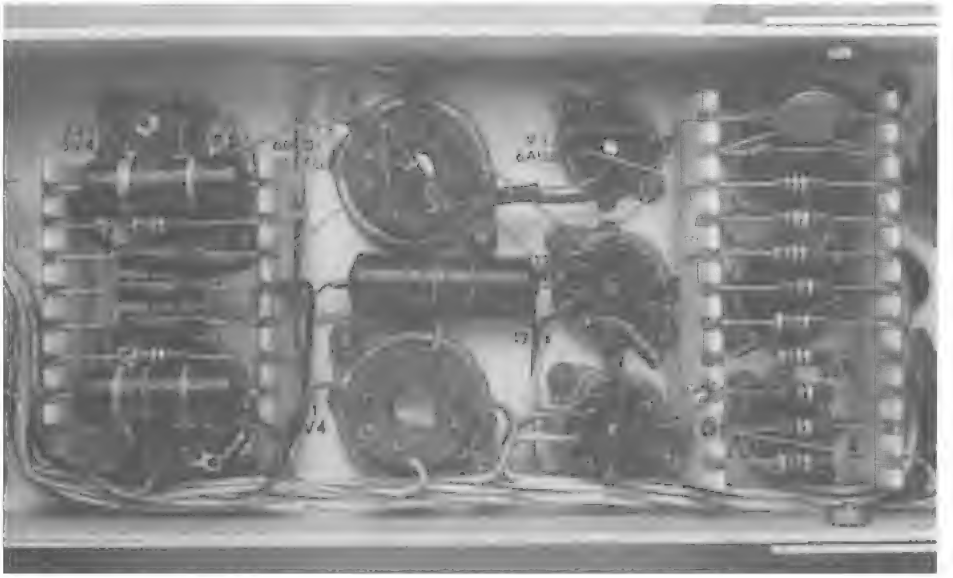


Photo 2—A well-evolved hardwire construction technique

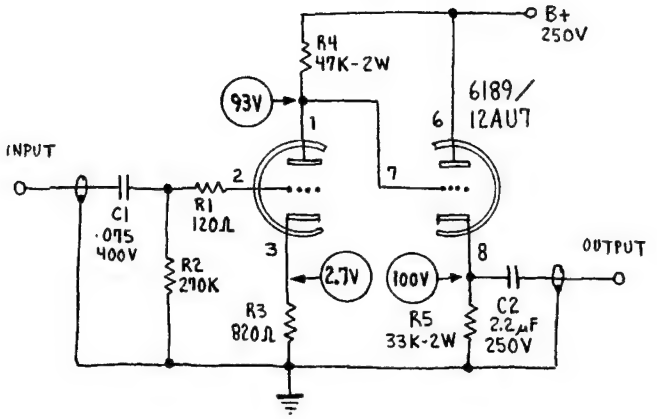


Figure 1 —A simple line amp circuit

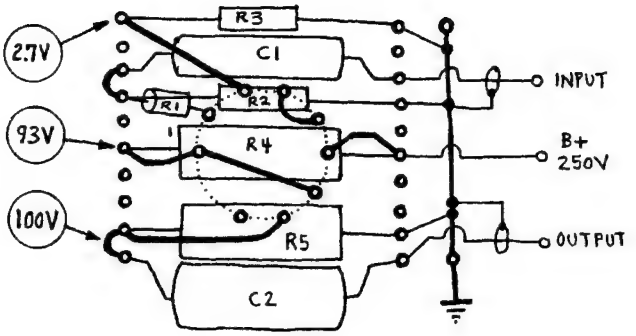


Figure 2—Wiring plan for the circuit of Figure 1

to dissipate 1/2 watt, I use a 2-watter. This aids in achieving stable circuit operation and long service life.

The final drawing plan, when it is verified by actual construction, should be saved for future reference. You may note appropriate electrode voltages as I have shown for the cathodes and plates of the two sections of the 6189/12AU7.

The first assembly step is to mount the tube sockets and terminal strips to the chassis. If you will be using both rows of terminals on the edgeboard connector, you should press-fit a length of artists' mat-board between the two rows of connectors as shown in Photo 4. This precaution avoids the possibility of electrical arcing between the opposing contacts. Artists' mat-board is a compressed cardboard used in picture framing; it is about the same thickness as printed circuit board material that would normally plug into the edgeboard connector. Cut the strip of mat board about 3/8" wide; its length will be determined by the length of the edgeboard connector. Use standoffs to mount the terminal strips; a standoff length of 5/8" is about right.

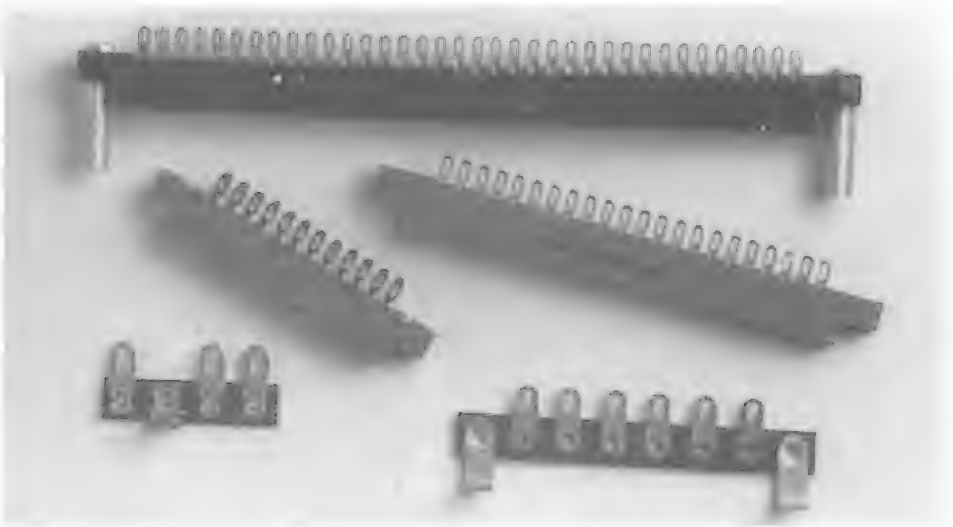


Photo 3— Modern edgeboard connectors and old style fiber terminal strips

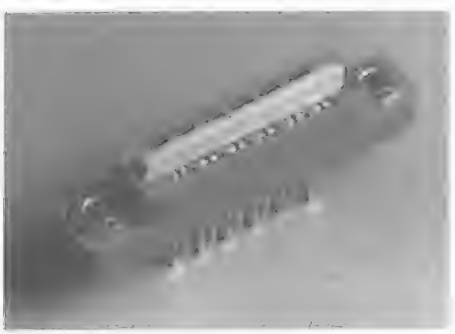


Photo 4— Plug in a strip of mat board to prevent arcing between the two rows of connectors



Photo 5— Circuit after initial wiring

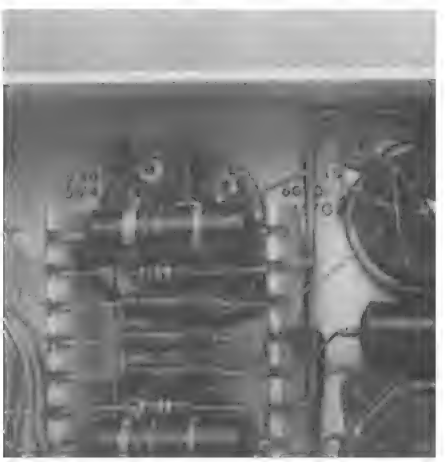


Photo 6 —The circuit with resistors and capacitors mounted

Photo 5 shows the circuit after the initial wiring step. I made connections between the tube socket and terminal strip with tinned copper buss-wire. The "grid-stopper" resistor (R1) has been soldered in place between the terminal strip and the



Photo 7—A side view of the circuit

tube socket. Wiring for the tube heaters, the "B+" and ground, and the input and output are also done at this time. If you are using shielded signal wires as I have shown, you may prefer to use teflon insulated types because of their superior heat resistance during soldering.

The final stage of construction involves the installation of the remaining resistors and capacitors, and Photo 6 shows the completed circuit. Photo 7 is a side view. When installing the resistors and capacitors into the terminal strips prior to soldering, do not bend or crimp the component leads as shown in Figure 3a. It is not necessary, and it makes subsequent removal of the part difficult. The terminal eyelet acts as a cradle support for the component leads as in Figure 3b. In Photo 8 you can see how this style of assembly can result in good cooling air circulation around the circuit components which should result in improved long-term reliability.

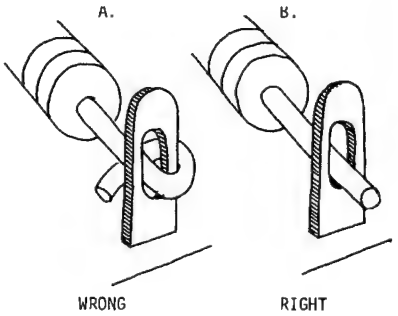


Figure 3 —The proper way to install conductors into the connectors before soldering

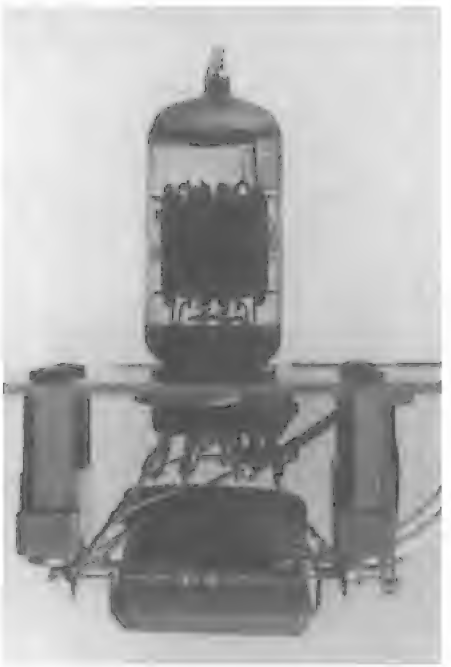


Photo 8 —The hardwire technique presented above allows for good air circulation around components

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Vacuum Tube Curve Tracing

by Alan Douglas

One annoying thing about working with tubes is the lack of information. Good tube manuals are hard to come by, and even the best are incomplete. RCA's five-volume manual only includes information on the tubes they made (the "not invented here" syndrome) and at most only includes the basic data and two graphs. Western Electric's is far better, but of course only covers W.E. tubes. Commercial manuals (other than Western Electric's) contain only plate-family curves, but non-linearity shows up much better on "transfer" or "mutual" characteristics, plate current plotted versus grid voltage, where it appears as curvature of a line. On plate-family curves, non-linearity appears as unequal spacing between successive lines, a difficult thing to see.

Finally, even if you had the full manufacturer's data, it wouldn't cover audio applications of tubes not originally intended for such use, such as RF transmitting or TV sweep tubes, nor all possible triode connections. And tube-manual curves only apply to average tubes made thirty to fifty years ago, not necessarily to ones we have now.

The answer is to plot them yourself. Years ago, tracing curves was a laborious business, reading values from meters and plotting them point by point on graph paper. Only tube manufacturers would ever have attempted it. With the advent of cathode-ray oscilloscopes, rapid curve-tracing became practical, and several designs for such tracers were published in the1940s, but they were quite elaborate and difficult to calibrate.

Tektronix made a commercial curve tracer in the 1950s, a scarce and desirable instrument now. But it is limited in ranges and modes, and in any event will read out only on a 5" CRT screen,with no permanent record other than a Polaroid print from a scope camera.

A two-axis chart recorder, or X-Y plotter, could replace the oscilloscope, and give a larger, permanent record on graph paper. Back in the 1950s, when tube-characteristic plotting was still important, a servo-controlled X-Y plotter was a very complex instrument.

Nowdays, though certainly not cheap, X-Y plotters are available, and seem to me to be the obvious answer to the problem. With minimal additional equipment, you can make plots for the very tubes you



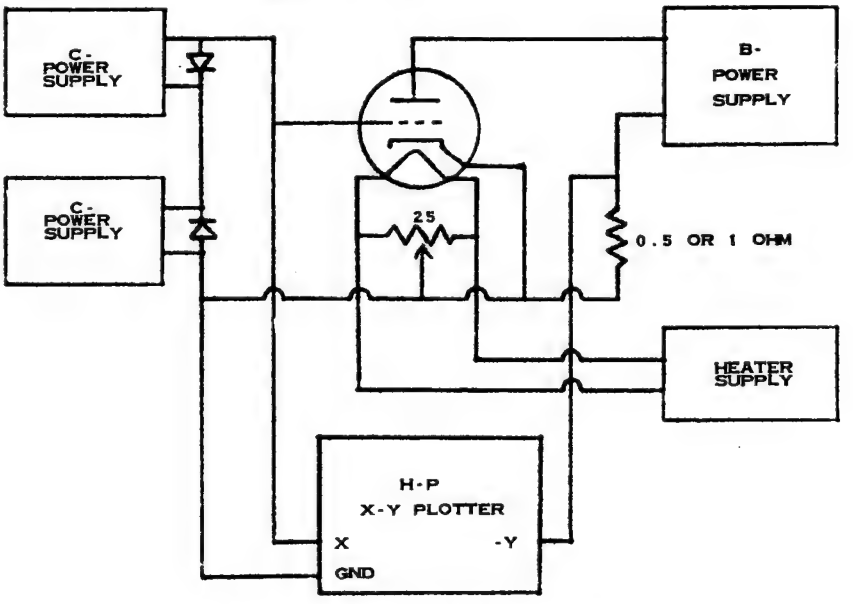


Diagram of curve tracing system

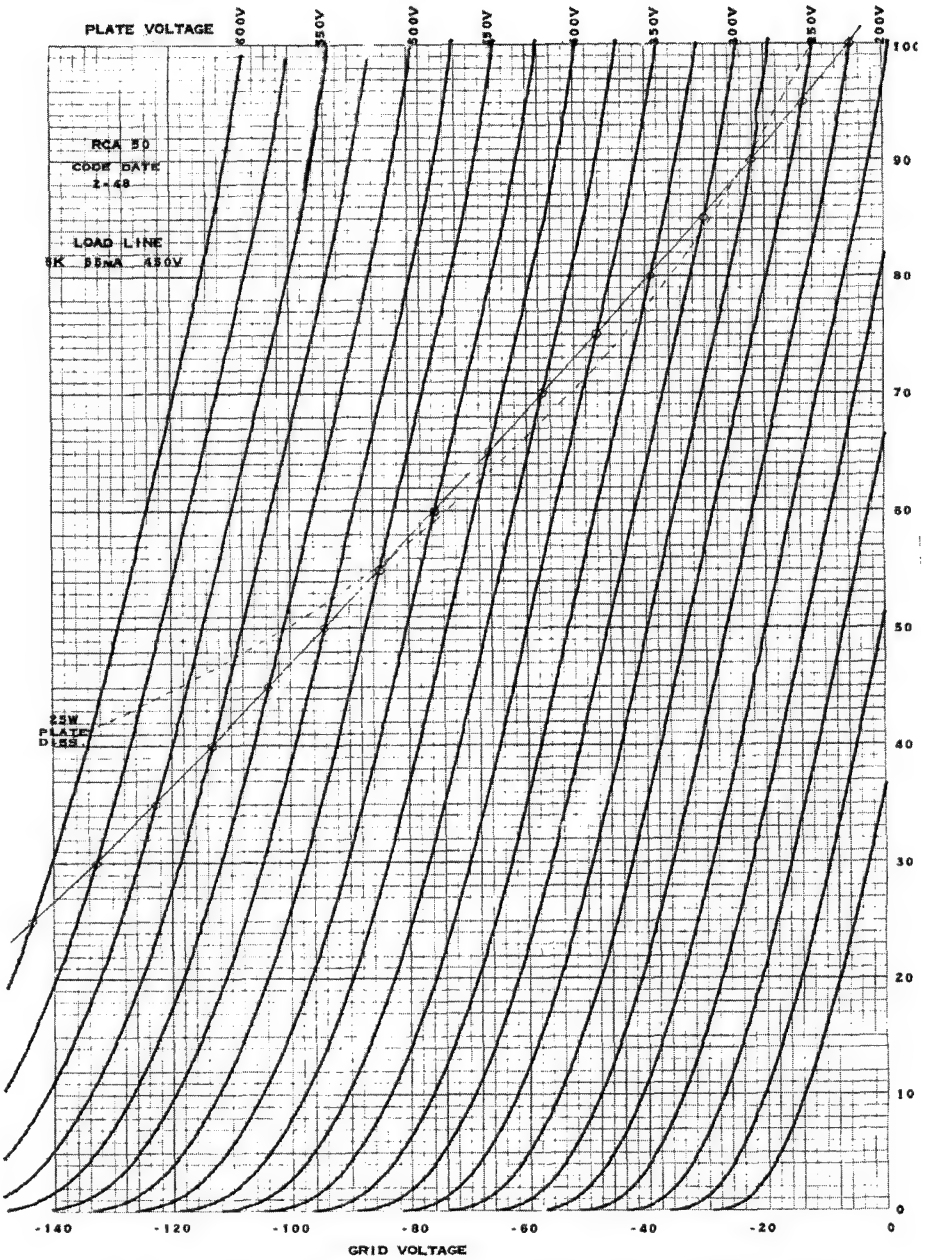
own, under any operating conditions you like. Furthermore, the resulting plots are easily large enough to determine tube parameters and distortion by graphical methods, no higher mathematics or computer simulations being necessary.

Other than the X-Y plotter, the equipment required is simplicity itself: regulated power supplies and a current-sensing resistor. Actually only the plate supply needs to be regulated, since in taking transfer characteristics, the plate is set to a particular voltage which must remain constant as the current varies from zero to maximum. A beam tube or pentode would of course require two regulated supplies. The grid bias is varied manually anyway, and its current demands are negligible, while heater supply is trivial.

As the old recipe for rabbit stew goes, "first catch your rabbit." Suitable X-Y plotters, while they are available, are perhaps not easy to catch. I was able to borrow a Hewlett-Packard 7046A which, after some overdue cleaning and maintenance, works very nicely. It has selectable input sensitivity and will even plot two Y channels, in different colors, up to 11 by 17 inches.

The one-ohm precision resistors came from my junk box (10 mV per inch on the plotter corresponds to 10 mA full scale; with 0.5 ohm, full scale is 200 mA). Chokes or ferrite beads on at least the plate lead are absolutely necessary to keep some tubes (6L6 or 6550) from becoming RF transmitters. The Y plotter input is reversed in polarity, to allow both channel grounds to be tied together. A 25-ohm pot across the heater leads provides the cathode return for directly-heated tubes. I sometimes use two bench supplies for grid bias, one being set at 20 volts positive, to be able to run the grid slightly into conduction without discontinuities in the plotted curves.

The photo shows some of the equipment I use. The PRL Electronics (who? what was an electronics maker doing in Rahway, New Jersey?) power supply provides 0 to 600 volts as set by switches; the 50-volt steps are very convenient for doing families of plate curves. It is rated at 100 mA but 200 mA is possible for a few seconds since the pass tubes are three rugged 6146s in parallel. It also supplies variable grid bias. This thing sat in my shed for more than ten years before I realized what it was good for. I have a couple of Hewlett-Packard 6209 transistorized power supplies, 0 to 320V at 100 mA, for plate or bias use, and a Lambda LH118, 0-10V @ 4A for heaters.



Set of curves for Type 50 generated with setup discussed in text

The panel in the foreground contains tube sockets and current-sensing resistors, but it has been replaced by a larger instrument with plate and screen milliammeters and provision for direct Gm measurement at any point (AC signal on the grid, and 10-ohm resistor in the plate with transformer coupling to an external AC millivoltmeter. All of this stuff came from flea markets or (the PRL) was free.

Tube curves are explained in Langford-Smith's Radiotron Designer's Handbook, fourth edition, pp. 26-27, while graphical methods of determining distortion are found on pp. 550-551 (pp.272-273 and 281-282 for the poor unfortunates stuck with the third edition).



Homebrewer of the Month

Al Bryant of Tomball, TX

When you meet a hardcore do-it-yourselfer like Alvin Bryant, you're meeting a person who really loves audio. Al has been at it for more than 40 years and he still gets as excited as a little kid over the stuff.

Back when he was working at Lawrence Livermore Labs in the early 50s, Al ran around with a group of hard-bitten Bay area hi-fi nuts who believed that triodes were the last word. Al stuck with the old three-element tube ever since, even though most of his buddies must have thought he was crazy back in the 60s and 70s when the 6550 was king.

Actually, the filamentary triode was already out of the mainstream power tube picture by the 50s. Even back in the early years of hobbyist hi-fi, triode aficionados had a bit of a retro twist, even though the word retro had yet to be coined.

Al built his first 300B amp around 1955 as a construction job for a musician friend who wanted the best amp obtainable to drive a bank of 16 speakers. This was back in the mono days when some sound buffs tried to get the width perspective of the orchestra by using a lot of speakers. The musician was serious enough and sufficiently well-heeled to pop for $900 for a single amp so Al built him a killer, no holds barred 300B PP job.



"Gotta watch it," says Al, "there's a lot of hype out there"

Everybody liked that amp, especially Joan, Al's better half and perhaps even a bigger audio nut than Al, if that can be imagined. Joan is the "ears" of the operation and she controls at least least half of the technical knowhow, so she wields considerable decision-making power. 300Bs it was.

Although they are longtime supporters of the 300B, Al has built innumerable push-pull pentode combos over the years. However, he remains fully convinced that PP triodes are the way to go. "6550s aren't bad and the extra power is a plus, but if you really want to hear the music, you got to use the 300B."

Al and Joan are definitely set up for serious audio experimenting. Years ago, looking forward to a audio-centered retirement lifestyle, they built a huge workshop outfitted for electronic construction, metal work, and wood working. Stacked on huge wall shelves big enough to use as bunk beds, sagging crates of mil surplus power transformers, chokes, and other parts were piled high. They have a small factory set up in there, I swear.

Back in the 70s, Al decided which parts he would need then bought 100 matching 50 mA filter chokes, 100 matching 150 mA chokes, 50 similar gray mil surplus power transformers, and so on. Gives a certain visual uniformity to his projects. All Bryant creations also share his "trademark" style of using aluminum baking pans for chassis. He lucked into a big sale down at the local discount store a while back and bought all they had. Some of the pans even come with slide on covers, perfect for shielding low-level circuits.

Once built and checked out in the lab, the latest experiment gets a spin in the big system in the house and *Big* is the right word. Al's mammoth reference speakers are about 8 or 9 feet high and 4 feet wide, no mini monitors here. These monsters have four 15" woofers, four 8" midranges, and a couple dome tweeters per side, and they put out enough sound to listen from anywhere in the house.

When we stopped in, Al and Joan were running the system on four mono PP 300B amplifiers with an active crossover. Like all speaker builders, they were deeply interested in crossover technology and I saw evidence of a lot of crossover projects out in the workshop, including LC line level passive crossovers, and speaker level crossovers where the coils were made out of whole spools of heavy gauge wire.

When Al needed some low DCR coils for his woofers, he just took a big roll of 12 ga. wire and measured the inductance on a



"Hey Al, you love 300Bs. Interested in trying out single-ended?" we asked

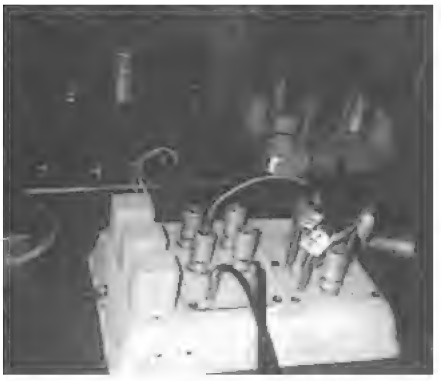
"Nah, not really," says Al

bridge while removing turns to get the desired value. Voila. Air core coils. Big honkers at that.

Given his reasoned, scientific approach to audio electronics, Al takes particular pride in his well-outfitted test lab. He loves to build various circuits and see how they perform on the bench. The circuits have to do an admirable job on the scope before they'll go into one of Al's amps. He builds a lot of stuff but he's not in a hurry.

Strictly a push-pull kind of guy, Al is unimpressed by recent claims for the superiority of single-ended. In fact he's a bit suspicious of the whole concept on technical grounds. He wants amps that measure good and sound good, with some reserve power. PP 300Bs give him exactly what he wants. Check out Al's simple 2A3/300B at http://www.soundpractices.com or send the mag an SASE and we'll cut you a copy.

Yeah, Al sure knows what he likes.We asked him if he was at all interested in trying out SE. "Nah, not really," he replied.



2-way active crossover in front, regulated power supplies in back



Al Bryant's one of a kind totally homebrew reference system featuring one dozen drivers per side driven by four mono PP 300B amps

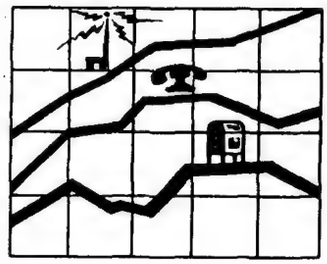
Al was interested in learning *about* single-ended amps but not so interested in doing it himself. He said he had at least five years worth of projects in the cue and he's happy enough with the trusty old push-pulls. We broke the news that Magnequest kindly donated a nice pair of single-ended transformers as sort of an honorarium for the recently-invented Homebrewer of the Month concept but he was not lured in by the offer.

"I have plenty of transformers here. Why don't you just give them to some young kid who is out mowing lawns trying to save up for a pair of output transformers," Al suggested. That's just the way Al is. What a nice guy! We'll have to write him up for him a free *SP* subscription or something.

Al said he's not into the hobby for money or fame, a good thing because there's not much of either to go around. Al said he's just real happy to to see that he has some company these days, as a homebrewer and as a lover of the 300B. Way to go, Al—keep that homebrew spirit alive!



The workshop : One 300B amp and power supply in foreground featuring Al's trademark cake pan chassis style. Wood shop in the back.



THE MANUFACTURERS' CORNER

welcomes J.C. Verdier

Laboratoire J.C. Verdier

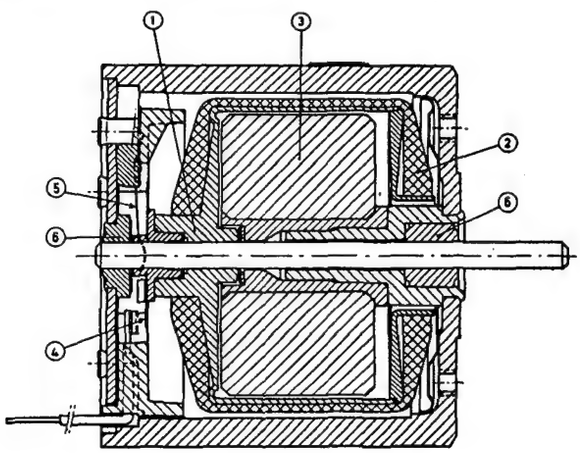
What a surprise! When I read the last issue of *Sound Practices*, I didn't expect to find an article on analog turntables, especially one speaking widely of the turntable I produce—the *Platine Verdier*. I am really surprised, because I know the author well. We met each other during some hi-fi shows and also another time in Germany in the shop of my distributor "Auditorium 23" in Frankfurt. I remember that we discussed some technical information.

Since I am no stranger to Dr. G.W., I don't know why he didn't contact me to discuss my perspective on the turntable. I would have gladly given him some useful information for his article.

First of all, let's approach the question of the motor. Certainly, I use a motor marked Philips, a name that could make one think of an ordinary motor, because that big European trademark is very prominent in the mass market for consumer goods.

That is misleading, because Philips is also very involved in very advanced technology. The motor used in the Platine Verdier is produced by a special branch named "Philips Technology." The motor is certainly not an ordinary part—given that the price is 2500 FF for one unit in the shop of the French distributor! That is not exactly a gift for a motor of diameter 40mm and 50mm high. It must have something very special inside. Let us see:

First of all, it is a "low inertia" motor. In the case of the Philips unit, that term refers to a very special technology. In a "low inertia" motor, the turning part—the rotor—consists of a copper coil, the turns almost parallel to the rotation axle cutting the field lines of the magnetic circuit, excited by a permanent magnet which is totally fixed. The weight of the rotor is reduced as much as possible, so the inertial tendency is small relative to the work provided by the motor.



1 Rotor
2 Rotor winding
3 Stator magnet
4 Commutator
5 Brushes
6 Bearings

Cross Section of Philips Technology Low Inertia Motor

I must say that I don't think that low inertia in itself is that interesting of a quality for a turntable's motor. It can even be a deficiency for players with relatively light platters, as indicated in my discussion of the value of mechanical braking below.

Another quality of the low inertia motor is much more interesting and relevant to the issue at hand: its rotation speed depends directly on the DC voltage. A simple integrated circuit regulator such as an LM 338 is enough to obtain perfect stability of the speed.

Let us come back to the motor description: The magnets are very powerful units in a small package. They are metallic alloy (nothing like cheap ceramic magnets). The collector and the brushes are gold plated to minimize the resistance of the contacts.

The axle of the motor turns in fitted and self lubricated bronze bearings, its diameter is 3mm. When the motor is powered at its nominal voltage of 12V, we hear the rubbing of the brushes on the collector. It requires a very silent environment to be able to hear this small noise.

In the *Platine Verdier*, the actual voltage applied to the motor is 3V for 33 RPM and 4V for 45 RPM. At those low voltages, it is necessary to press your ear directly on the motor to hear the commutation sound.

In the *Platine Verdier* system, the motor is located far away from the platter and any vibrations are effectively isolated from the turntable by a piece of thread used as a drive belt. In essence, the inconvenience of that tiny vibration is completely removed in practice.

Now, let us approach another point: Dr. G.W. explains that playing a record with a stylus consumes energy and that this energy is variable on account of the changes of musical modulation, resulting in drive speed variations of the platter.

That is absolutely correct and it is one of the basic problems facing the turntable designer. The author then explains how to remedy this: the motor must renew the energy as swiftly as possible to keep constant speed, that is the reason for using a low inertia motor. I think that if this were true, no turntable could work well, because no motor is good enough. Fortunately, we can make use of more powerful tools to settle that problem.

The first tool is well known, it is the platter's inertia. The heavier the platter, the more it works to counter momentary variations in speed, but the challenge is to make a very thick and massive platter which doesn't ring like a bell.

The second tool is less well-recognized than the first: the constant-coupled brake system. Since the player stylus consumes variable amounts of energy, we have to mask that consumption by permanently consuming much more energy by the use of a brake. The larger the ratio between the energy consumed by the brake and the energy consumed by the stylus, the better the turntable works.

To be clear: only a few models of turntables have this device. To understand the concept better, have a look at a Thorens TD 124 which uses a brake with Foucault's current excited by a permanent magnet, or EMT 927 which has a completely mechanical brake consisting in washers placed around the axle with the capability of adjusting the pressure and therefore the braking action.

On my turntable, the brake is present but invisible to the casual eye—it is furnished by the axle and the bearing. The two parts are unusual in their very large dimensions. The two facing surfaces of about 60 cm^2 separated by lubricating viscous oil form the brake.

Numerous times, I had to explain to customers that it could be a big mistake to replace my viscous oil with a more fluid oil to "allow the platter to turn for a longer time." This total misunderstanding of the problem is unfortunately very widespread. Some time ago I heard that there exists a turntable which is lubricated by pressurized air, without any braking action whatsoever, and it enjoyed good commercial success despite this obvious deficiency!

Let me wrap up this discussion by describing the general design features present in my turntable.

Examing my turntable, the first thing you will notice is that the platter is very heavy and massive, weighing about 16 kg. Such heavy weight forbids the use of a ball bearing support for the spindle. It would quickly produce intolerable rumble due to wear.

To avoid that inconvenience, I use a magnetic suspension. The drawing shows clearly how two opposite magnets placed in treated cast iron magnetic circuits are configured to bear all the weight of the platter by their repulsive force.

The bearing interdependent of the platter is Zamac fitting: it is an alloy of zinc and aluminum which is easy to work, self lubricating and silent. The axle is of course of tempered and rectified steel, its important diameter is 20mm.

The base is a paving stone of granito (sort of cement conglomerated with marble splinters). A special molding procedure permits us to realize that part very easily. The cavities forming the air suspension are molded in and don't require any additional working.

The three suspension springs are fitted in the middle of the cavities isolated by a foam rubber washer. That is the fitting of the air suspension, completely effective against feedback effects.

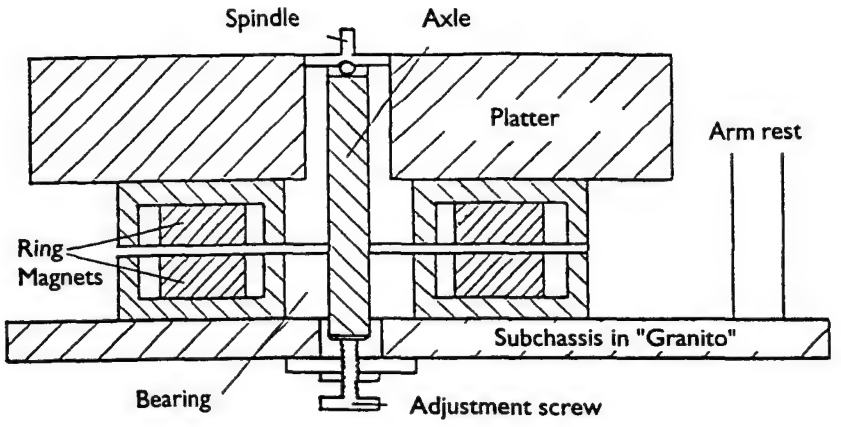
The drawing shows the adjustment screw of each spring which permits adjustment of the horizontality of the turntable. The arm rest is produced in massive aluminium block to give a good rigidity.

"Platine Verdier" is produced like that since more than 20 years. To bring the discussion up to date, I have to add that I recently designed a new base machined out of high density fiberboard weighted down by steel plates. In this base, the finish is more luxurious and the black lacquer shines like a beautiful concert piano. The motor is fitted in a box totally separated from the platter assembly. The whole setup weighs about 45 kg (not counting the motor unit) for dependable stability.

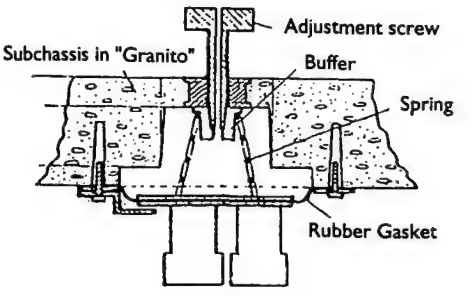
The drive chain still relies on a linen thread, an arrangement satisfactory to all users of the Platine Verdier, except for a few!!!

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Cross Section of Turntable



Cross Section of Pneumatic Foot

Ennemoser

The bone doctor of musical sound

by Joe Roberts

Over the last ten or so years, the audio world recognized the vital role of materials in musical reproduction. There's a lot of concern with resonance control and tuning. Audio metallurgists and jewelers tout the advantages of .9999 OFC copper and soft annealed silver. There's plenty of discussion about Teflon™, Delrin™, and other lab-born brand name materials but how often do you read about human bone and tissue, the business end of every audio system, in the pages of the glossy audio magazines? Music as we experience it is, after all, a sensation of shaking bone and flesh at the most basic level.

Ennemoser is the first person I met who truly appreciates the fundamental notion that our hearing apparatus is made of bone and the whole thing is mounted in a skull that is also made of bone. Ennemoser said it took a long time to recognize this powerful truth because laziness of thought and language makes us stupid about some very important things.

Even after 20 years of working with these concepts, Ennemoser complains that he often feels silly talking about bones given all the scary monster movie connotations we attach to this most natural substance. Everybody who hears about Ennemoser's works feels obliged to throw in a few Frankenstein jokes to lighten up the conversation. Ennemoser himself jokes about it.

Because he constantly struggles against old habits of language, Ennemoser is concerned about being cast as one of those audio guys who invent colorful theories and then elaborate on them using verbal logic and poetry. Real science builds theory from experience, not the other way around, he rightfully insists.

That kind of thinking is what got me interested in Ennemoser's ideas when I am usually inclined to let wacky tweaks and overly creative reinterpretations of audio physics pass me by. When I first heard about Dieter Ennemoser, I thought he was just another flaky smokescreen artist.

After I talked to him and read his stuff, he impressed me as being down to earth, almost too down to earth for the average Joe to get a handle on. Ennemoser definitely seems more interested in digging deeper into what is right in front of his nose rather than inventing wild new stuff. The irony is that people like that often come up with the most radical inventions and freshest insights.

The other thing that impressed me about Dieter Ennemoser is that the man builds violins. Can't do that with theory and thought experiments. Even Stateside resonance gurus Michael Green and Shun Mook can't build violins. Demonstrated success in this craft is a strong credential in the practical black arts of vibration, resonance, and musical sound. The nature of materials and their behavior is all that matters. Musical capabilities are paramount.Violin makers get paid for sonic results. Call me a hick, but I'm impressed – Ennemoser is not just another unemployed TV repairman trying to break into the luctrative tweak accessory market.

Ennemoser started out as a student of mechanical engineering but he doesn't like to talk about it much. He claims it took 20 years to unlearn the mindset imposed on him by the books. He found that much of what he needed to know to produce instruments was completely outside the usual domain of mathematical physics and the usual measurements had little to do with the art of the violin and the life of music.

As Ennemoser developed his talents as an apprentice, the learning curve he had to follow to perfect his craft steered him off the trail of routine scientific engineering and usual violin making practice. The ear is the ultimate lab instrument for the violin maker and nothing else could tell Ennemoser what he knew in his bones.



Ennemoser followed his ears to a point that got him into trouble with the authorities. Based on his acoustic research, he developed some innovative violin designs outside the tradition of the official instrument makers' guild. They tried to force him to stop making unauthorized instruments. He tried to claim an official "artist" legal status as a creative violin smith, but the Austrian authorities didn't buy it and they threw his butt in jail for his guerrilla violin making activities. This was back in 1989.

I can understand why the conservative violin makers' mafia didn't appreciate Ennemoser's instruments. They feature inset angular depressions designed to enhance radiation of "C37" frequencies, lending a very non-traditional almost "punk" look to instruments from the atelier of Ennemoser.

Even worse in terms of traditional requirements, Ennemoser's instruments are tinted in unexpected colors. He prefers the sound of blue violins, but says that pink and wine red are also good sounding colors. In short, body colors, "meat" colors, are what sound good.

In order for violins to enter competition, they must be tinted orange using a specific aniline synthetic dye, Ennemoser complains. "Orange is the worst possible color for a musical instrument because it is the opposite of blue." This is insanity, according to Ennemoser.

On the question of the sound of colors, Ennemoser claims psychic kinship with the great von Karajan. The maestro customarily required his players to wear sky blue shirts or wine red jackets, although he also liked bright vibrant red. Maybe most people are moving too fast to pick up on subtle energies like the sound of color. I'm willing to concede that sensitive individuals can tune into dimensions of perception that I miss entirely.

However, it is difficult to discuss even the slightest possibility of color sounds because we are conditioned to think that such a relationship is a totally crazy concept. With that kind of an attitude, how can we ever learn?

While in the slammer, Ennemoser wrote the essay which was later published in Switzerland and excerpted below. He says that until he went to prison, he was unable to gain much sympathy for his cause because he was fighting a well-entrenched lobby with no fame or money behind his cause. As a political prisoner, a status that attracted attention, Ennemoser's voice was heard.

Ennemoser stuck with the case and, after his story was told, he ultimately won out. It was a long five year battle but the government is now one of his great supporters and also one of his customers. For examle, the *Tiroler Landesmuseum* recently purchased a blue string quartet for its permanent collection of local arts.

Looking back on his tangle with the system, Ennemoser has no hard feelings. It was a learning experience for everyone involved.

Ennemoser's Practical C37 System

On the surface, Ennemoser's C37 theories might come across as just another abstract and flaky explanation thrown together to account for an ethereal sonic phenomenon. Actually, the C37 scheme is grounded in the earthiest, least ethereal substances there is. C37—Carbon at 37 degrees C. Carbon at body temperature. Warm bone.

Fearing the worst, the first thing I asked Ennemoser is whether his stuff has bone in it. I flashed on the romantic image of Dieter in his workshop drilling cartridge mounting holes in a tonearm made from the shinbone of an antediluvian ox chipped out of the glacial Alpine icepack up in the mountains.

Dieter said "no bone in my stuff" but I'm pretty sure he liked the idea. He joked about how many of his friends are now using pieces of actual bone in their projects, inspired by his ideas on the special resonance character of bone.



Right Blue violin from Ennemoser's Tirolian workshop exhibiting special angles designed to enhance C37 patterns.

Left 18 C 37 technology 3000 Hz LF driver with angled diaphragm and laquered cone

Below Detail drawing from Ennemoser's patent for transducer with "discontinuous variation of the aperture angle" designed to produce decay behavior similiar to the human auditory organ. Specific angles of 163, 157, 140, 114, 98, 82, or 66 degrees are employed. (European Patent # EP 0 491 139 B1)

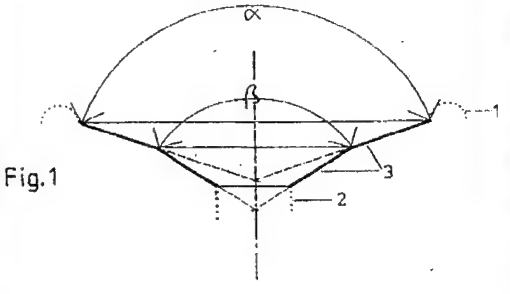


Fig.1



Basically, what Ennemoser is excited about is the *sound of bone* at body temperature when struck. He believes that the "dry" sound of bones is a very special illusion that occurs because our auditory apparatus is itself made out of bone. Our hearing bones filter frequencies in a particular way and then feed them to a brain which evolved over millions of years of processing sound stimuli transmitted through warm bone. Bone is a privileged material because we are made of it.

The interplay of music and the mind is a dance of the bone vibrations inside our bodies and instruments which vibrate in a manner relevant to our carbon-based perception setup.

What Ennemoser is working to identify and manipulate is the C37 sound pattern that bone produces. For a quick sample of C37 pattern, you can tap your skull right behind your ear using your fingertip. You will hear a satisfying thunk that is controlled yet rich, not a bad material for speaker cabinets, huh? The point is that you're always doing this C37 test while listening, whether you realize it or not. All of the interconnects in our ears are bone.

So, that's how Ennemoser does most of his research. He taps on stuff, *plays it* as it were, and listens for the sound. Like I said he's super down to earth. He is a tuner, not a storyteller. Indeed, Ennemoser claims that his biggest challenge was trying to learn to think without using language. The logic of violins and music is not linguistic.

Ennemoser's C37 system builds on a set of practical tools and techniques. He found that certain angles enhance production of C37 frequencies and he uses these angles in his violins and in his speaker cones. The speakers use a patented multi-angle cone optimized for C37 signal processing.

Another novel idea of Ennemoser's is the notion that physical dimensions of electronic circuits are important determinants of sound. Changing the size of a printed circuit board, for example, can impact sonics and this can be tuned in accordance with C37 principles.

On the level of materials, Ennemoser uses a special C37 lacquer that you can paint on your favorite musical objects to benefit C37 patterns. Since the resonances are temperature related, the lacquer is formulated for use within a particular temperature range, e.g. there is 20°C lacquer for room temperature applications and a different formula to use inside heat generating electronics.

(continued on p. 37)

According to Stein Hi-Fi, the C37 *Speziallack* (lacquer) does wonderous things for CD players–two coats on the component side and mechanical parts of transport (watch the lens!). C37 *Lack* is also good on interconnects, they say. Recently, a German mag painted a Rickie Lee Jones CD with C37 and in a blind panel test, all 20 of the auditors preferred the smoother, more liquid sound of the C37ed version. It is also alleged to be great for painting circuit boards, parts and all. 1001 uses in the listening room.

Ennemoser sent me a sample 10 ml bottle of C37 *Speziallack 20*°C and a bottle of C37 *Spezialverdünnung* (thinner). Once I had these blue vials of bug juice, I had to try them out and I started looking around the room for stuff to lacquer up. A 10 ml vial is enough to do one 15" paper cone, two 8 inchers, one CD player, or other small scale job. Coverage depends on the surface.

The first thing I did was unscrew the cap and take a good deep whiff ...aaah, smells just like an old world workshop. My eye rested on the white cones of my Lowther PM-6As. I resisted the thought. No, I like them just the way they are. My mind raced on. I couldn't help it. Huffing lacquer will do that to you.

C37 *Speziallack* is a new concept in resonance tuning but its far less strange than some of the things people are doing out there. I drew faith from Ennemoser's comment about how C37 tuning produces "a more lively, open, and warmer sound and turns sharpness into brilliance." I really like that image and that was what I was hoping that the C37 would do for me. Even though I know Ennemoser is anti-linguistic, language is a difficult habit to shake.

So, the deed is done. The verdict won't be in in time for this issue however. C37 *Speziallack* takes *months* to dry completely on absorbent paper cones (much faster on non-porous surfaces). So forget quick A-B comparisons — fine by me since I'm not into 5 minute clinical psych lab experiments anyway. I like to take the time to make evaluations in the real context of my normal musical listening activity.

Nor am I into the tweak neurosis that I saw coming if I sat here for a couple months listening to the C37 *Lack* dry, so I decided to put the Lowthers away for a time and get on with my life while it cures. Started to sound interesting before I wheeled them out to storage, two weeks after the C37 aplication.

I wasn't out looking for Lowther mods since I think they're very good as is but I figured that in order to give the C37 lacquer its best shot, I should put it on something fine to start with instead of wasting it on a $50 CD player in hopes that it would magically transform into a Wadia. Nobody said it was magic, especially not Mr. Ennemoser.

Bone Doctor (continued from p.35)

Ennemoser is the first person I know to argue the point that temperature is a critical element in resonance tuning. For example, he says that glass sounds like C37 in the 70°-72°C range and at another point in the 180° range. Most preamp tubes run cooler than this and power tubes run too hot. You can experiment with concentrating the heat around your preamp tubes with a cardboard hat to get up to the 70°C range and try it for yourself.

Casual Reactions



by Herb Reichert, Audio Note NYC

Uchida: The Japan Homeboy

Thirty years after the Second War the fruits of Japanese manufacturing established a firm beachhead on American soil. The words Made in Japan appeared on tools, cars, toys, and on the majority of consumer electronics products. Americans purchased these items, not because of cachet and exoticism, but rather because the price/performance ratio was good.

Nearly all Americans believed that U.S. and European products were of better quality, but for the millions of consumers who bought these new imports, "The price was right!" At the same time, Japanamation youths were flying to America in search of cachet—and maybe some 'new-wave' excitement.

During the Sid and Nancy days of the late 70's, a most unusual trio of Japanese friends arrived in New York City. All the way from a rock n' roll band on Hokkaido Island off of Northern Japan (near the USSR) came Noriyasu Komuro, Tadataka Uchida, and his wife Sung Hee Lee. Expatriating an ancient culture, they arrived for the Second Centennial celebration looking for work in the music business. Sung Hee did vocals, Uchida played lead, and Komuro played bass.

Komuro got a job as an electrician while Uchida washed dishes and Sung Hee waited tables. The Japanese restaurant where Uchida and his wife worked was run by a successful man who was good at what he did, but secretly hated the restaurant business. One rainy, cold winter day the man who owned the restaurant arrived looking super glum and carrying a briefcase. He lined up his employees and told them, "It's over...I quit!"

Dumbfounded, the employees all stood silently, looking at each other. "Who wants the restaurant?" was his next line. Still, nobody said a word. Sung Lee kicked her husband in the foot and automatically his hand went up. A couple of years later, Uchida and his wife are partners in one of the most successful and fashionable restaurants in SOHO.

Today, Sung Lee is the proprietor of another fashionable macrobiotic Japanese eatery and Uchida is free to pursue his musical dreams. I forgot to tell you, Komuro and Uchida were avid single-ended amp designers back on the island near the USSR. They started in the late 1960s! Komuro brought one of his 211SE amps with him when he came from Japan and now, Sung Lee uses Western Electric 212E tubes for lights in the restaurant. Horns and 300Bs play music to eat macro by.

In the 'go-go' 80s, while this trio was doing food and electricity, I met a serious Japanese youth named Ryoichi Kimura. We became instant friends and partners in a triode-audio import business (Eddy Electric). He introduced me to Shindo, "sree-hundred-bees", single-ended amps, Western horns, and original (indigo dyed) Levis.

By 1990, Ryo was gone and I missed my Japanese friend. Ryo took about a million WE300Bs and went back to Japan to study Buddhist sculpture. So I forced my best friend J.C. Morrison to get 'high fever' and join the 'Dark Lantern' school of audio engineering. He and I walked, talked and slept single-ended triodes and horns. Eventually, J.C. and a carpenter turned Dark Lantern named Garber opened a store called fi in SOHO. It was there that J.C. and I met Uchida, Komuro and his girlfriend, the "Fire-cracker". They saw the triodes in the store window and couldn't stop themselves from wandering in.

Two weeks later...we were all down in the basement (even the "Fire-cracker") with our irons in a constantly heated state. Amps and speakers of all descriptions began literally pouring out of the basement door. We were all fanning each other's flame.

Five years later, Fire-Cracker's a hacker, Komuro and J.C. are famous amp designers, I am a partner in Audio Note and Uchida is the proprietor of April Audio, a company specializing in the import and sale of choice Japanese audio components and books about single-ended audio.

Where is it?

I seem to have this love thing about foreign audio. Maybe it's the Krells? I don't know why, but I keep getting caught up in overseas audio circles, Italy, Japan, Pakistan, Germany, France, Malaysia, Australia, the Philippines. I know little groups of triode/horn fanatics all over the globe. One day, just for fun I arranged for two of my Filipino friends, Ding and Jun, to visit Uchida for a taste of the Japanese audio experience.

At lunch the next day I said,"Well, how did you like Uchida's feral system?" Ding and Jun laughed, "We couldn't find his place" they both said in harmony. Turns out, they were looking for someplace normal. Uchida's 'den' is hidden in the East Village, behind locked steel gates, and looks totally abandoned. The front is completely covered in graffiti and there is just a big lock and no sign. Without a guide you could never find it.

What is it?

Ding and Jun finally got their Uchida experience, but please, take your shoes off and let me tell you what is behind those graffiti covered gates. It is just like *MJ* magazine come to life! It's like the hornspeaker home page. I go there to learn. Uchida collects everything musical: electric guitars, gramophones, radios, posters, records, tapes, amplifiers, recording equipment, books, speakers and tubes. Most of this stuff he has stashed away in the mountains and in warehouses, but there is still enough in this completely Japan-style living environment to be completely inspiring.

In Uchida's den you are transported to a back alley of the Akihabara. It is so narrow you can barely walk, you must take your shoes off. There's a big tree-slice for a table and a small low wooden bench to sit on. The rest is tube amps, records, and exotic STUFF. You really can't move around at all! A trip to the bathroom is a project; you get lost looking at the floor-to-ceiling tubes and speakers and musical exotica.

He will serve you something like 29 kinds of dried plums and a Japanese mountain soup filled with vegetables that, I guarantee, you have never seen before. In fact, it's likely you have never, ever tasted any of the food he serves. I bet you have never listened to music on a system like his either.

He has five or six types of speakers set up. Altec *Valencias*, Western Electric 755As, Lowther PM6As in Brociner TP-1 cabinets, PM7As in custom cabinets, and a couple of other Altec speakers I don't recognize. All of these speakers can be played on a moment's notice. This is nothing! Just a few speakers.

For a full-function preamp the legendary Japan Homeboy uses a circuit straight out of the RCA Tube Manual, with red base RCA 5691s in the phono stage and GE 6SN7GTBs for the line, permalloy choke filtered power supply and paper in oil caps. It's the amplification that gets really wild: WE27As, 212Es, and 300As, GEC DA30s, DA60s, and DET25s, PX25s, Mazda AT20s, Globe screen plate 50s, and my favorites, the Cunningham CX210s/310s.

Tell me the last time you heard a transformer-coupled, Western Electric 205D tubed, single-ended amp with Tango (#10429) super-permalloy transformers playing Miles Davis? This is a one-watt amp with a $1600 pair of the world's best quality output transformers. Can you beat this for triode exotica? These are the kind of amps and speakers that inspired the whole triode movement.

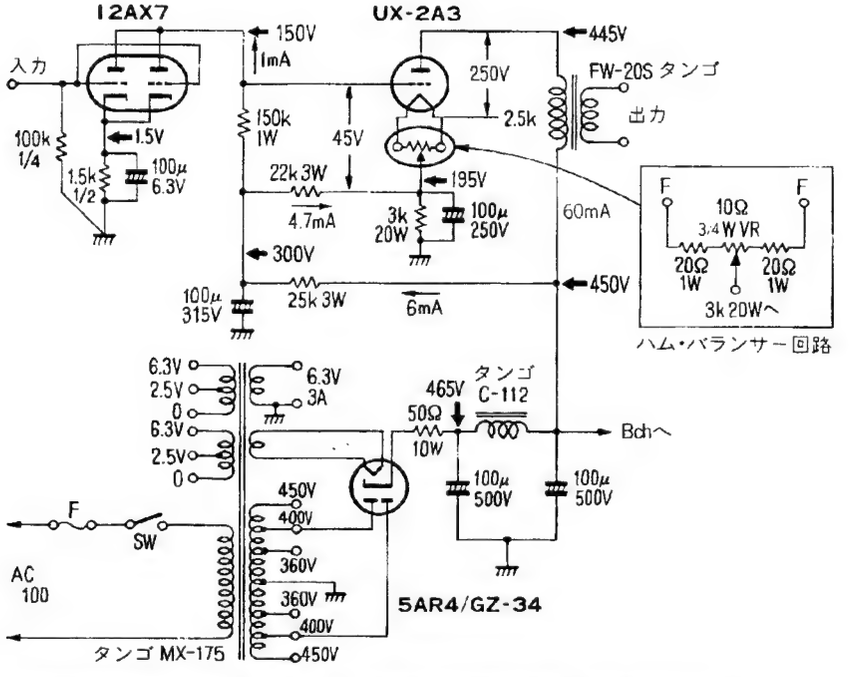
Trust me, the future of high-quality music reproduction is in the 1/2 watt to 5 watt amplifier! I am totally serious. To go very far beyond the WE300A/B amps you must go to the more exotic very low power tubes like the 10Y, the 45 and the 71A. Forget the 205D. Most of us will never even see one of these tubes, let alone listen to music through a pair. This is hyper-triode, ultra-fi Japanese style. So is Uchida.

I spend my days smoking my pipe and playing records through Kondo amps and giant German horns yet the kind of audio I hear at Uchida's is still totally exotic; very low power triodes driving permalloy core transformers from Tango and Nature Sound, these little beauties driving super high efficiency speakers and sounding like Mel Torme in a smoky room. This is the shadow of twenty-first century audio. Get Dark Lantern now!

When I closed my Tango/Black Gate business there was a void. For a few years there was no place to get this level of audio parts outside of Japan or Italy. That changed when Sung Hee took over the restaurant business. Uchida became free and willing and now he sells ultra-fi stuff imported from Japan. He can bring the Akihabara to your doorstep.

From here on, this article is shameless advertising and promotion. I can't help myself. I have a deep attachment to all of these products. I am not going to recommend you buy these items, I am going to demand it! Here are a few of the Japanese language books that every English reading tube lover will cherish.

First you have to buy both volumes of Isamu Asano's book, *Miwaku No Shinkukan*



Shishido's famous direct coupled Loftin White 2A3 design

Dr Bottlehead says:

Hey bottleheads! Have you built an amp with TV tubes? Ever put QUADs, Lowthers, and A7's in the same room? Did you make a tube output for your CD yet? NO? Well quit readin' and dreamin' and get that iron hot. It's time to put your solder where your theory is. Join **VALVE**, a gonzo, dumpster-divin' tube audio club, stuff your head with a monthly newsletter full of radical tube ideas, and build somethin'! Send me 25 bucks ($35 overseas) and I'll send you 12 monthly issues. Heck yeah, we got back issues. Two years worth!



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Small amp maker or Hobbyist

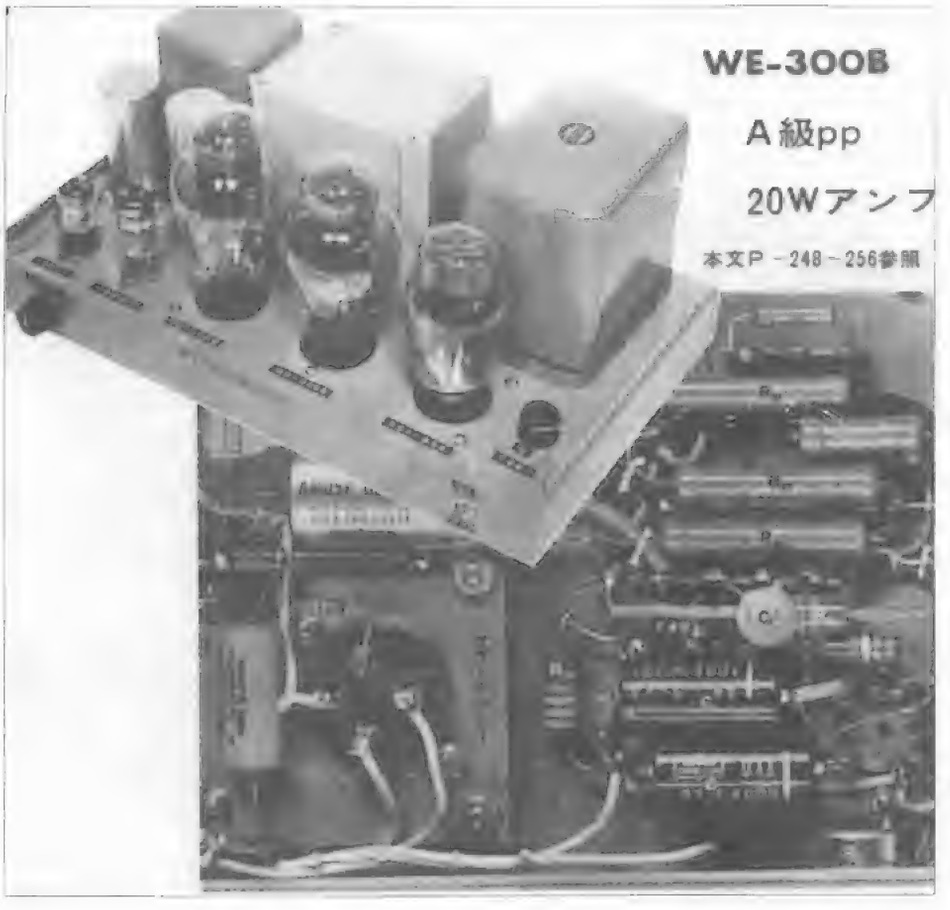
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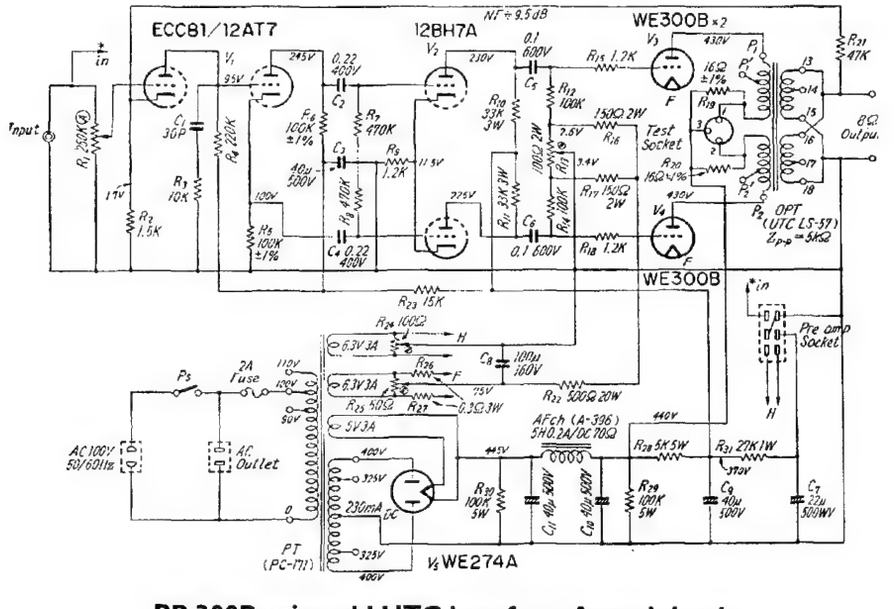
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PP 300B using old UTC iron from Asano's book

Amp ($100/two volumes). I would be selling women's shoes today if it weren't for these two books.

Asano was the most famous triode amp designer in Japan. He started building and writing about single-ended amps over thirty years ago! These books offer complete designs for dozens of different directly-heated triode amps. There are chassis layouts, circuit diagrams, tube curves, operating points and color photos of the internal wiring. The photos are so good, you can read the values on the resistors. Asano uses ALL kinds of iron, UTC, Tango, Western Electric, Tamura, Lux, etc.

These books make you feel like you built the amplifiers. You can really zoom in and absorb the details of these designs. The color pictures of home made amps from the 60s, 70s and 80s are the perfect inspirational tools. You can build your new life around these designs.

The big man, the top dog in the world of home-built triode audio is Koiuchi (Nobu) Shishido. Nobu was the first guy to champion SE amps in public and one of the earliest rediscoverers of the 300B. His adaptation of the Loftin White 2A3 reprinted above was the design that started it all in Japan. Today he designs amps professionally for WAVAC and is a steady contributor for *MJ* and other experimenter magazines.

Shishido's book, *Single-Ended Amplifiers with Transmitting Tubes* ($60.00) is an absolute must-own for all wannabe designers. The main theme in the book is how to use Class B and C transmitting triodes in Class A as single-ended audio amplifiers. Why bother? Because if you really love tubes, these types of triodes are super exotic, sound great, and they can be found for a fraction of the cost of WE300Bs or DT-25s.

Nobu can show you ways to use interstage transformers, and ways to load the cathodes of triodes that you will not find anywhere else. Buy it and study it!

The Classic Valves ($70.00) is the history of the vacuum tube with 860 tube photos. Reading Japanese would help a lot with this book, but if pictures of exotic, perfectly formed tubes gets you wet...

On the other hand, we all need the *World Tube Manual* ($120) by Masamitsu Yamakawa. Tell me where else to find complete curves and data on 7200 tubes?

Now that I have gotten you hot, knowledgeable and ready, it's time to heat up the irons. But wait! Before you begin your "big and final" amp project, please take this advice: Buy transformers that you know for sure are good. As we speak, there are tens of thousands of triode amps using Tango or Tamura transformers. Hirata, the man who founded Tango transformers, started building transformers during the second world war. No one has more knowledge or has greater proof of his design ability than this man. Tango trans specs are very conservative and the craftsmanship is on the highest possible level. People who have tried them all prefer Tango. These are trans you can use proudly for the rest of your life.

Hirata's NY-10S (45% permalloy) and 10429 (78% permalloy) 10 watt trans are simply the best outputs I have ever used. I have tried every kind of transformer that can be bolted to a chassis and nothing comes close to these monster Tangos. Only Kondo's all silver/ceramic/steel creations are clearly better.

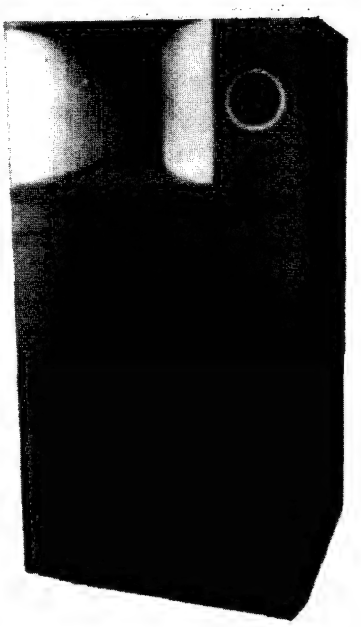
Permalloy is used to create transformers that are very sensitive and responsive to low level current stimulation. Delicate, small signal information that conveys color, texture, and breathy little details of tempo and space are recovered, that are completely lost in ALL 'low nickel alloy' cored transformers. If you are not interested in hearing the other 50% of the musical information, that you never knew was on the disc, don't buy permalloy. Remember, what you don't know can't hurt you. However, if you are curious and can afford the hefty price tag ($430-$800 each) don't hesitate.

Don't listen to the wankers, who have never experienced permalloy, who say it saturates too easily, don't read the books they are reading either. Just run your output tubes at the right operating point and use sensible speakers and go straight to heaven.

I know this is complete advertising but I love this man and I love these products. Hey, I am not talking about Audio Note am I? [Wow, that's a switch!— ed] Tell me, when's the last time you heard a manufacturer shamelessly plugging his competitor's product? If you want more of this kind of stuff to become available, don't just write for literature, buy something! It is an investment in the future for all of us.



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Martin G. De Wulf in *Bound for Sound* 6 :1995

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Experimental Audio Invasion Issue 12

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. . . and MUCH MORE !!!

Alien influences

These days there are more audio magazines around than ever before, yet one has to wonder about the very future of print in an age where more than anybody wants to know about most topics is accessible for free on the Internet. Paper magazines are expensive and resource-thirsty to produce and circulate. It costs a few dollars to print up a magazine and a few more to mail it, then it takes days if not weeks to get where it's going. The same information minus the paper wrapper can be disseminated electronically in seconds for almost free. For that reason alone, paper media are more or less doomed to eventual extinction, sooner or later.

It is an old story how economic considerations drove electronics design from the $20 tube to the 20 cent transistor. Well, the same forces are assuredly at work in the information delivery business. It's still a challenge for a producer to get consumers to pay for digitally-served information in these early days of the technology, but this will surely change as people get used to the concept of paying for raw info rather than tangible paper artifacts, buying "ideas" not books. Inevitably, print journalism will have to find a new home, but in the meantime there's a golden age of audio journalism afoot.

Ironically, the same digital revolution that threatens to destroy the magazine fostered a parallel revolution in desktop publishing technology that has totally transformed the landscape of the magazine racks. There used to be significant barriers to entry in the publishing biz but not anymore. Today, anybody with a used computer and spell checker can hack together a decent looking publication on the kitchen table. Of course, certain talents are necessary to put out a *good* magazine and computers don't make that any easier, but the mechanical aspect of publishing certainly isn't the killer it used to be. The end result is more magazines, *different* magazines, a great thing.

New magazines brought a lot of new ideas and viewpoints into circulation but the diversity of fact and opinion accessible to the masses multiplied dramatically when online publishing came along. A cheap modem is all you need to get a message out to the whole world. It is quite inspiring to see what people can come up with when freed from the commercial considerations that shape mainstream print media, acting out of a pure hobbyist interest. Money has always been an effective motivator but nothing beats a labor of love for that feeling of connectedness. There is a lot of garbage out there but if you're not on the Net, you're missing a lot of hot audio info.

Already, after only a few years, the alien influences of alternative mags and online resources have seriously eroded the conceptual monopolies the audiophile media barons used to enjoy. The profound influence of the glossy magazines on "high-end" audio in terms of agenda setting, marketplace gatekeeping, and even definition of self for many audiophiles is depressing evidence what happens when the public discourse on a topic is manufactured and controlled by a few commercial institutions.

Given the romantic explorer self-image cultivated by the "High-End" all these years, one would think there could have been a bit more variety of thought and product out there. For decades, audio was like the adolescent who expresses his individuality by dressing exactly like all his friends. The hi-fi scene degenerated into a tribe of like minded recommended-component zombies, speaking the same bizarre lingo, listening to the same awful audiophile records. Finally, there are signs of life, signs of experimentation and growth, thanks to the widening information pool and channels for direct hobbyist to hobbyist interaction on a global scale. Now, that's romantic!

Just as the so-called "underground" media have always done, the hobbyist-driven efforts show the mainstream players to be exactly what they are: large creatures that must keep their hungry maws in a deep trough of advertising dollars or die. The bigger a mag gets, the more it must eat, so further out into the fields of lowest common denominator and mass appeal it must roam. Specialization is a luxury of small circulation media, as is the freedom to pursue perspectives independent of advertising considerations. The big mags still rule the contemporary marketplace, but if you want a glimpse of the future, go to the alternative channels of information and discover what the experimenters are doing years before you'll read about it in *Stereophile*, *Audio*, or any of the other well-fed paper dinosaurs.

The rise of alternative info outlets is not a question of "the small axe that cut down the big tree." The popularization of access to public communication media is the biggest axe of all time. Clear the landing pad, the invasion has begun.

Ankoru

by ANDY GROVE

Audio Note. U.K.



Hey, don't drop that thing on your foot!

Musical information is a dynamic four dimensional continuum, like the one posed by relativity theory, consisting of three spatial dimensions and time, all inseparably interrelated. A system for music recording and reproduction must transfer this continuum and faithfully reconstruct the original sonic performance in the listening room. Test instruments are supposed to ensure that the transformation of the continuum is linear and accurate to certain parameters.

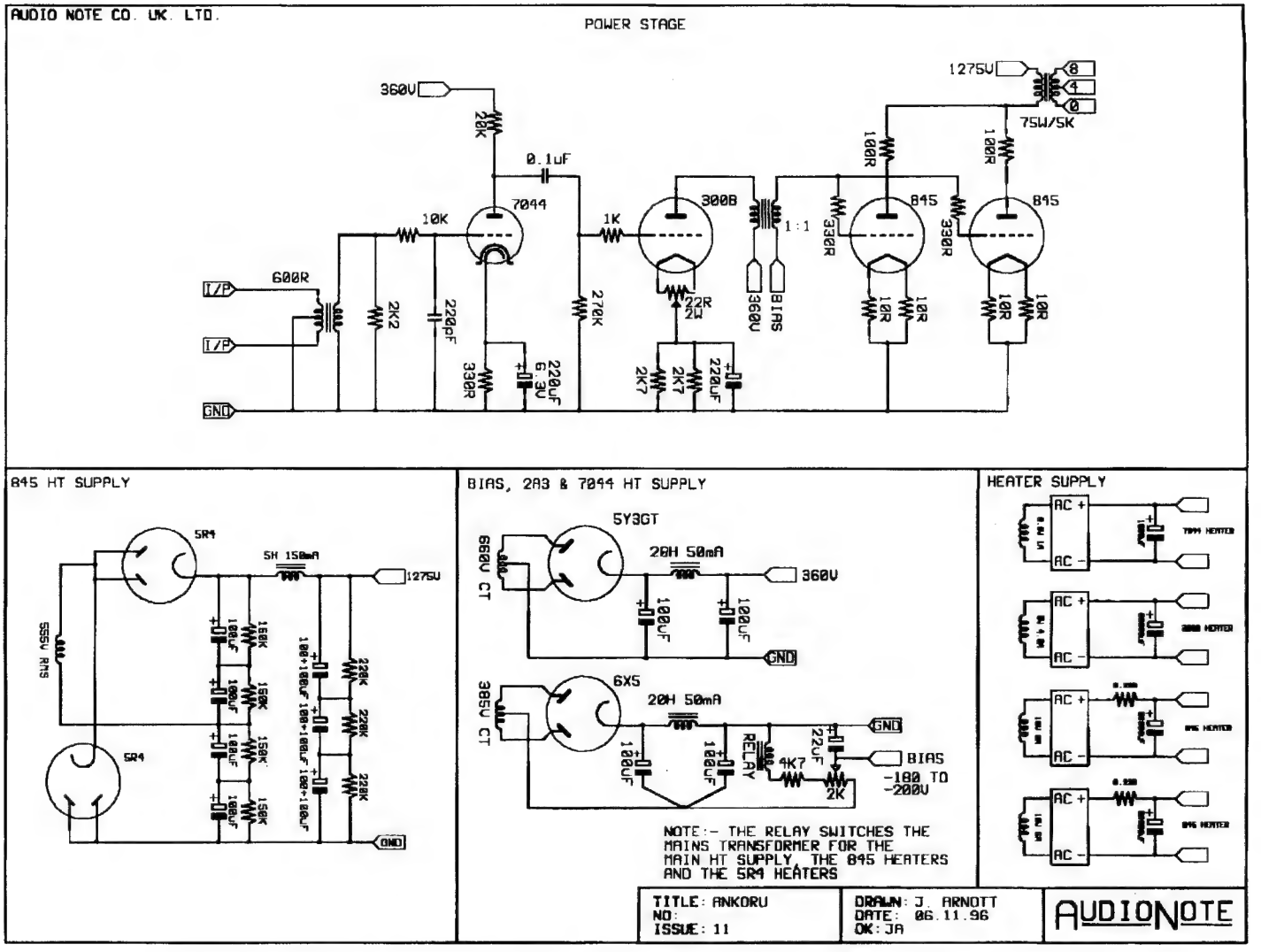
Alas, these instruments and the mathematical models that we use, such as relativity theory, lack the spontaneity and emotional content vital to music. Somehow our primitive method of recording scratches into a vinyl disc captures some of this emotion, and the lump of rock we call a stylus is able to extract the information and convert the vibes into a signal ready for the amplification chain. The amplifier, therefore, must not only perform well electrically. It must also convey emotion in order to fully satisfy both the analytical mind and the inspirational soul.

These days, science is beginning to discover an essential, almost mystical, interconnectedness of everything. It is intuitively obvious that the character of the universe on a macroscopic scale should rely on the properties of the subatomic particles of which it consists. At the same time, the character and properties of those particles is defined by the universe at large, the whole system mysteriously holding itself up by it's own bootstraps, each piece of the giant jigsaw fitting exactly into place without deficiencies or excesses.

It is only by virtue of an intellectual gesture that we perceive a condensed, solid, and definable part of the web of reality, yet we have deceived ourselves into thinking that our mental creation is the be-all and end-all of existence.

Most of our old scientific "laws"– including those currently used to judge sonic performance – are only close ups of the whole picture. I'm afraid we are not seeing the wood for the trees.

Certainly these measured parameters do have some relevance in terms of overall performance, but to recreate a musical event, an amplifier must work on both a macroscopic scale as a part of a communication system between the performance and listener and on a microscopic level as a



Schematic diagram of author's design - Audio Note *Ankoru* SE parallel 845 70 Watter

collection of valves and parts which must be tamed and optimized for the task at hand.

A magazine article can only skim the surface of any design philosophy and, of course, there will be shouts of "what the *@$! is this guy on?", but I hope my discussion of the *Ankoru* design will be interesting nonetheless.

Starting with the basic precept that each part of the amplifier should fit exactly into place, and have a character defined by the overall requirements of the system, the validity of *feedback* and *push pull* operation, two pillars of traditional amplifier design, are immediately called into question. These concepts are purely intellectual constructions, created in laboratorieswith no motivation from natural music, and I am convinced that they detract from sound quality as a result.

In practice, the ultimate purpose of feedback and push pull operation is to make amplifiers easier to make not better. In any event, reducing harmonic distortion to vanishingly small levels and increasing bandwidth from DC to cosmic rays does not make a more musically satisfying amplifier. Specs must give some satisfaction though, 'cos we all know a guy who slinks off to the bathroom with a copy of his tranny amp spec sheet!

I agree that limitations such as distortion and bandwidth abberations unquestionably colour the sound and should be eliminated, but beyond that I maintain that there are more important areas to be considered if musicality is the ultimate goal.

According to my way of thinking, all of the above leads to the assertion that the overall topology of an amplifier must be single-ended and there must be *no* feedback. Transistors and all things silicon sound unnatural...put sand in the signal path and you get gritty sound! So, let's proceed directly to *valves* and, in particular, the simplest and purest amplifying device.

The materials used for the construction of the passive elements of the amplifier are just as important since the signal must pass through them. Every material has a tonal coloring effect, so only highly-specified, high-purity, listening-tested materials are suitable.

For example, in the *Ankoru* we use only Black Gate and Cerafine electrolytic capacitors for the audio circuitry. These caps eliminate that electrolytic mushiness without going over to the brashness of certain plastic caps. The valve selection was guided by the notion that the different sonic signatures of each type should be complimentary, leading to the goal of a sound that possesses both strength and finesse.

Before I go on to describe the *Ankoru* circuit in detail, I would like to say a few words about transformers and transformer coupling, since transformers play an important role in the design.

In any valve, waveform distortion is caused by the characteristic parameters of the valve changing in sympathy with the applied signal. In a standard RC coupled triode circuit, the valve is set up with a quiescent current (Iq) flowing through it and the load resistor, yielding a particular quiescent voltage on its anode (Vq).

With a negative-going input signal, the current is reduced and the anode swings positive due to the reduced voltage drop across the load resistor (Rl X Iq). The reverse is true with a positive-going input signal, the valve's anode current is increased so the voltage on it reduces due to increased drop across Rl.

There is a problem with this, however, because as the anode swings positive and the current decreases, the transconductance of a valve goes down due to the curvature of its characterisic. Of course, the reverse is true with a positive-going input signal, the transconductance goes up with with the current.

This means that the positive part of the anode swing is compressed and the negative part is expanded– waveform distortion. Usually, this distortion only becomes serious with very non-linear valves and/or large voltage swings. When we want to drive a fairly meaty output valve we need to swing a lot of volts because the mu of these types is necessarily low to keep the anode impedance down to keep loudspeaker damping up. In this circumstance, waveform distortion can easily rear its rather ugly head.

We need a system for keeping the current through the valve as constant as possible over the anode swing, i.e., a high load impedance. Increasing the load resistor on an RC coupled stage can only go so far, however. One soon runs into problems of resistor dissipation and PSU voltage if the anode current is kept at the optimum level.

The SRPP stage and his other active loaded cousins, such as the mu follower, have never really delivered the goods for me. Close listening reveals a lack of focus and immediacy compared to even the humble RC coupled stage. Anyway SRPP is a feedback device and quite often that scheme doesn't work very well electrically either, especially with the low impedance valves we would like to use as drivers. Simply pretending that you've got a low output impedance just doesn't cut any ice in the world of real audio.

For large power valves, a low AC drive impedance is necessary because large valves have large and therefore highly capacitive grids. Thankfully, the low gain keeps down the Miller Effect, but it's still there, so for good HF response, there is no getting around using a good low impedance driver.

From the standpoint of sound quality, for a strong sound we need a beefy, low impedance driver. Wimpy driver equals wimpy sound. Drive two 845s with an ECC83 and it'll be like putting a model aircraft engine in a Chevy Impala. Not exactly awe inspiring.

The DC resistance of the grid circuit must also be kept low to control the effect of another rather annoying bugbear, grid current. Unfortunately, the vacuum in many modern valves is far from perfect, so there are quite a few gas ions floating around inside the bottle. Some of these ions will collide with the grid and draw electrons from the grid circuit. If the grid resistance is high, the grid bias will be modulated in tune with the signal, a real no-no in my book.

Also the grid may occasionally be driven positive on signal peaks, causing the grid-cathode diode to conduct, rectifying the input voltage in the manner of a shunt diode supply with the coupling cap as the reservoir. This action makes the bias voltage more negative, reducing the quiescent current through the tube, sometimes to the point where it will only conduct on peaks (Class C). In fact, a severe peak can cause the amp to cut off altogether, resulting in a total loss of output.

Worse still, the grid resistor/coupling cap combination acts as an RC time constant, so the effect lasts for some time after the overload has passed in sort of a time-delay distortion mechanism.

Reducing the grid resistor to combat these effects is no solution. We want a DC grid resistance similar in magnitude to the impedance of the driver valve, i.e. a few hundred ohms not a few hundred kilohms.

Making your grid resistor 600 ohms will likely kill the driver stage and, anyway, would require a coupling capacitor so big that the RC time constant would put us right back where we started.

To cure the voltage swing problem requires a circuit element which has low DC drop but a high AC impedance. Plus, we need a low DC resistance in the grid of the output valve. And the device should efficiently couple the driver valve to the output tube's grid.

The driver transformer is exactly what we need for the job. Its primary inductance presents an extremely high AC impedance to the driver valve and reflects the anode impedance of the driver into the grid circuit of the output valve. A good driver trans will have a primary and secondary DC resistance on the order of 300 ohms, so the problems associated with grid current are more or less eliminated. This is a resistance 1000 times lower than I've seen in some designs.

Ideally, the transformer secondary is left unloaded, i.e. there is no "damping resistor" put across it to cut ringing. An unloaded transformer sounds better and it gives the driver valve a higher impedance load.

There are two large-scale problems with driver transformers, HF frequency response and LF frequency response. These two requirements are mutually exclusive to a certain degree and many commercially available transformers sacrifice one for the other. The Tango transformers, for example, seem to go for impressive-looking HF specs but they have diminutive primary inductances



which limit the LF performance.

The problem is compounded by the unbalanced DC current imposed by SE operation, which requires that the number of primary turns must be increased to counterbalance the loss of permeability caused by the air gap in the core. Leakage inductance is proportional to the square of the primary turns so it's a real pain in the butt.

The driver transformer in the *Ankoru* has to handle 45 mA and still have superb bass, so it took some heavy calculator work and a few trees worth of paper to get it all working! [The *Ankoru* interstage trans will be available as a DIY part–*ed.*]

I love the sound of large triodes like the 211 and 845. The 845 was used in this amp because it offers greater power in Class A1. The 211 is a more voltage sensitive valve than the 845, its *mu* is higher but then so is its internal impedance. It can't swing a lot of current at the low voltage end of the anode swing without having the grid driven positive into Class A2. When pushing the grid above zero volts, it no longer reacts as a high-impedance terminal. It starts to draw appreciable current, corrupting the input signal in a most unattractive way unless the driver impedance is extremely low.

The grid-cathode diode impedance of a 211 is about 2k, so we would need something around 100 times lower or hideous distortion would result. The waveform distortion could be corrected using feedback but why build an amplifier that is intrinsically nonlinear?

The 845 can sink a lot more juice where the 211 starts wheezing, but since the *mu* is so low, it requires a driver stage capable of considerable voltage swing. The 845s in the *Ankoru* are biased at -100 to -200 Volts for an anode current of 75 mA at 1200V B+, they look into a load impedance of around 6k, and put out a formidable 70 Watts. The output transformer has to cope with 150 mA DC and hold its 6k impedance down at LF, requiring a high primary inductance. This takes a serious hunk of iron, but the *Ankoru* output is just such a beast and the bass is awesome, if I do say so myself.

To keep the drive signal to the output valves clean requires a driver valve of excellent linearity. One could use an indirectly heated valve such as the 6BX7, very linear, or the slightly less linear 6BL7, but low impedance, low *mu* directly heated valves are definitely the best choice.

Since this amp has to be built using valves which will be available for some time into the future, so that replacements can be made throughout its life, it was necessary to use modern versions of either the 2A3 or 300B. I originally experimented with the 2A3 as I wanted a measure of its clarity and immediacy, but these valves have a very nasty habit of making toilet related noises even in the output stages of amps, and using one as a driver was impossible. I even tried some NOS samples but many were only marginally better, only the best and therefore rare and expensive examples were quiet.

So the 300B was chosen, and it brought its characteristic warmth and musicality to the amp as well a greater impact to the bass. The 300B is operated with 300V across it and an anode current of 45 mA so it will last for ages, no more current or voltage was necessary for driving the 845s to full output. The 300B's output is in fact so large that the 845s will be freaking (and so will your wife and the neighbours) before it runs into trouble which makes its jobs and the job of the input stage easier.

Various input configurations were tried, all using the E182CC/7044 valve for its powerful sound. The original and best sounding configuration gave the amp so much gain as to be impractical. Long speaker leads acted like antennae and transmitted the amp's output into the input leads causing instability. Super high quality cables and careful system setup would eliminate the problem but as this is a commercial amp it has to be dealer proof so a simple, single stage RC coupled affair was settled upon. The 7044 was always run at a high current to really bring out its flavour.

The *Ankoru* is interfaced to the preamp via a coupling transformer to allow balanced operation and to properly ground the grid of the red hot 7044. A switching system permits regular unbalanced input as well. The *Ankoru* is intended for use with the Audio Note M3 which has output transformers and balanced outputs.

Ideally transformer coupling between input stage and 300B would have been used but even super quality transformers impart a signature upon the sound (ultra mega quality ones don't however) so a special copper foil capacitor with paper/oil dielectric was used to couple from 7044 to 300B. This capacitor like all caps has a sonic character but it was used to avoid a buildup of one type of timbre caused by the cascaded transformer coupled stages.

The power supplies are fairly standard, and of course valve not silicon, remember microprocessor parts in the power supply equals computerized sound. If you want your record collection to sound like a bunch of cheap CDs then use silicon rectifiers for the audio PSUs like all the other junk in the shops. In fact, I would use valves for the filament supplies if I could– Tungar rectifiers such as the Ediswan 68506 would work for those who dare [*Cool! –ed.*] or AC straight from the mains trannie but then punters would winge about hum. I could have built gargantuan supplies which would have caused the primordial fires of a nuclear power station to die but this amp had to fit into a (almost) domestically acceptable chassis.

So a sensible but effective approach was taken, capacitor rather than choke input filters were used to get maximum voltage efficiency and chokes were used to get ripple down. The capacitors in the PSUs are directly in the signal path so they need to be of excellent quality and here the Cerafine types come into their own. They have a smooth and refined sound. Energy storage was not taken to extremes but the main HT for the 845s holds 50j of energy (the caps on the input side of the filter are isolated from the audio circuit by the choke and therefore don't count).

It is necessary to have a rigid supply. Smaller caps generally sound a bit sweeter in the mid and treble but if you want a decent bass quality the last thing you want happening is the PSU flapping about all over the joint. You don't put a lawnmower carburetor on a Ferrari engine.

Going for oil drum sized caps doesn't work either (Question: Can you think of a trannie amp with super solid bass and complete and utter crap everything else?). Super sized capacitor supplies can pump out heap big LF current transients but they take heap big time to recover as well, and the impedance of the giant electrolytics just skyrockets as the frequency rises.

Regular capacitor power supplies integrate the demands placed on them so a bigger supply reacts a smaller amount but everything takes longer. So the PSU for the 845s is suitably scaled for an excellent all-round performance, solid bass through to sweet and delicate treble. Things are made a bit easier because the energy storage of a capacitance is proportional to the square of the voltage on it and at 1200 V it doesn't take a big capacitance to store a lot of grunt.

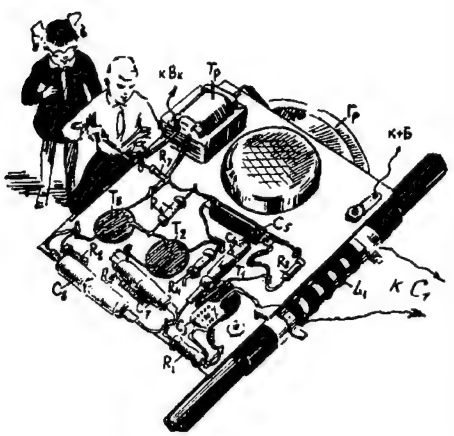
To minimize the effects of the 845s on the preceding stages the 300B and 7044 have their own supply from a separate mains transformer. Both are run from the same rail so that the 7044 has a really juicy supply to suck from, and remember the 300B is running into an unloaded transformer so there is minimal supply draw variation due to constant current operation.

The 845 supply is rectified with two 5R4s in a voltage doubler configuration to ease the peak inverse voltage requirement, the output impedance and peak current go up but it is still satisfactorily within the valve's limits. The driver stage HT is via a 5Y3 rectifier and the bias supply uses a 6X5. The main HT is delayed by the bias supply, the driver stage and bias power is applied when the amp is switched on. The 6X5 is an indirectly heated rectifier and so takes a little while to come up.

When the bias voltage reaches a safe value the big 845 power transformer is switched in by a relay. If the bias fails for any reason the relay will drop out cutting the power to the 845s.

All in all I am pleased with the end result, the *Ankoru* when partnered with a good preamp such as the M3 and a good turntable gives a superb musical performance. It can resolve the smallest nuances and subtle timbres of classical music and deliver the visceral impact of techno, even with relatively inefficient speakers.

In short, this was the design brief: A single ended amp which would give that SE charm and musicality but which would also send the big solid state boys back to their silicon shrines to have a serious rethink.





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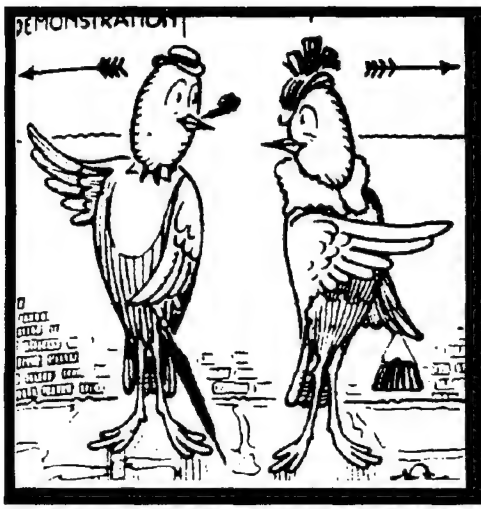
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Lowther, another opinion.

by Marc S. Wauters

More fuel for the inner fire

I've been following the almost euphoric acceptance of Lowther loudspeakers into the hearts and homes of American Audiophiles over the last few years with great interest, and some concern.

With the popularization of the single ended vacuum tube amplifier and the resultant quest for high efficiency speakers it was only a matter of time before Lowther drivers would be recognized as a viable contender.

Having spoken with many "new" Lowther enthusiasts during the past few years I realized that there are quite a few misconceptions floating around in regard to both Lowther as a company and Lowther drivers. I hope that anyone considering the purchase of new or used drivers may benefit from the information provided here.

IMPORTANT! *Be aware that while the following text contains many facts, much of it is also based on MY personal opinions developed through MY experiences. Opinions are like noses, everybody's got one and everyone's is different. Have an appropriate amount of salt handy.*

If you've been reading the articles in *Sound Practices* and maybe surfed over to one of the Lowther Club web sites, then you have a pretty good idea of what these drivers are all about.

High efficiency drive units that can cover the entire audio frequency range at deafening volume levels with only a few single ended watts of power. The purists dream come true ...well, almost.

Now not all of what you are going to read here is necessarily positive. But to dispel any suspicions to the contrary, I would like to say, capitals Mr. Printer please and in bold if you can:

I AM ABSOLUTELY A GREAT LOWTHER FAN !!! ("Worlds *greatest* fan" was already taken.) However, I am also painfully aware of the following facts:

#1: Separating Lowther "Cult Lore" from real-world usable information can be difficult, but it is possible. And as I have come to learn the Lowther factory is not always a good source of information unless you can get hold of the chief designer, Mr. Roy Hopps, but that can be difficult.

#2: In spite of being called "The World's Finest Drive Units", Lowthers are not perfect and you must accept their flaws in order to enjoy their strengths. False expectations based on wrong information (sometimes put out by Lowther themselves) poor product quality and plain old misuse of these drivers has caused quite a bit of frustration for some Lowther enthusiasts. This has to some degree already been pointed out in other articles.

#3: Unlike roses, "A Lowther, is not a Lowther, is not a Lowther" (thanks Harvey...and Gertrude). Or to put it another way: Not all Lowthers are, or were created equal. It is important to know at least some of the technical details of what makes a Lowther sing when considering a purchase. Especially older used ones which may have made it to U.S. shores over the last 20 years must be scrutinized carefully.

#4: Dealing with Lowther directly in regards to product purchase can be extremely unrewarding. While I know a few people who have ordered drivers and actually received them in this lifetime, this is the exception! Many stories are in circulation suggesting that common Lowther procedure is payment in full up front for the merchandise and wait to see what happens. Maybe you'll get it, maybe you won't.

Quite some time ago a friend of mine ordered a pair of PM-4As for which he paid in full up front. After a year and a half of lame excuses from Lowther he was talked into taking a bunch of Feroba drivers instead. Unhappily he accepted because his money was gone and it was quite apparent that he wasn't going to get what he had ordered.

In other words you should get your Lowthers or spare parts from a knowledgable dealer, representation available in most parts of the world nowadays. Your chances of getting a good specimen of Lowther product go up dramatically when someone with a little knowledge and love for these speakers has inspected them!

I'm sure all of the above may sound a little confusing. But if you read on, I assure you it will all fall into place.

My personal Lowther history:

Most of my early years were spent in Europe, Germany to be specific, where Lowther has always enjoyed some varying level of popularity. I first became aware of Lowther sometime in the late 1970s when they were really quite the rage. Kind of what's going on in this country right now. WARNING!

Design and production quality were almost at their best during the late-70s. It should be pointed out that much of Lowther's good reputation was based on products from that time period. The design of the drivers was practically perfect around 1975 and there have been NO REALLY SIGNIFICANT IMPROVEMENTS to the product since then.

I watched Lowther go from extreme popularity during the late 1970s to a low somewhere in the early to mid 1980s. Dealer after dealer tossed in the towel and gave up the line. Few were able to handle the constant changes made to the drive units, changes which never improved the sound. Production quality was more variable than the weather in Germany, going from reasonably good to lousy and back within weeks.

Lowther took some pretty big hits back in the 1980s and it was really all their own fault. Unfortunately, some production and quality control problems persist to this day, which is to say that a knowledgeable and quality-oriented Lowther dealer is definitely worth seeking out.

Through thick and thin, there were some people who've always kept the faith, maybe because they fondly remembered the good old stuff. And eventually I met one of them and he really helped me out a lot. More on that below.

By the time I was ready to purchase my first set of Lowthers, the only places you could still buy them were large mail order houses. Most of the dealers with auditioning rooms had stopped carrying the product. In late 1981, I finally bought a pair of "C" series PM 6 Mk1s, the ones with the "Special Silver Speech Coil". I had been warned by several people not to get the silver voice coil option because the silver voice coils were said to be unreliable, having a tendency to come undone.

Of course, this is exactly what eventually happened, but I *had* to have silver. I think all the stuff I read in *Hi-Fi Exclusiv* about Audio Note of Japan and their "Silver Philosophy" back in the early 1980s had something to do with it.

I never did get to use these drivers while I was still living in Germany because in early 1982 I moved back to Los Angeles. My Lowthers, my vinyl, and some select audio gear followed about 6 months later. Not long after I had put my drivers into some experimental cabinets, one of them started to "scratch". So I took them both apart and found that, as predicted, the inner winding of the voice coil had come off the former and was now flopping around in the air gap.

To my great dismay, I also found that the voice coils of the two drivers were of completely different lengths. One was 6 mm long whereas the one on the broken driver was 9mm long!!! Remember what I said about constant changes? Well, these were *supposed* to be identical drivers. I was able to find out from a friend in Europe who had a sort of "Hot Wire" to Lowther at the time that they decided to change the voice coil length of that model from one week to the next. Of course, there was no change in model designation and I just happened to get an "old one" and a "new one" ...hey, thanks a lot, folks.

Replacing the defective cone-voice coil unit was not possible at the time so the still good driver went into the closet and I went on to listening to something else. But I couldn't quite forget the brief experience of listening to those drivers. Although far from perfect the way I had them running, there was something special about the "Inner Fire" (a German expression) , intensity and fine dynamics these speakers displayed even at very low listening levels.

Sometime in 1984, I found out about someone who was selling complete Lowther speakers in Canada and I was able to secure the last pair of Accolade 2s they had for myself. This was the "New Generation" of Lowthers. This speaker consisted of a PM 6 C and a C45 driver in a very small enclosure. Although it was claimed to be a folded horn, it was actually something like a multi-vented reflex enclosure of some kind.

Upon inspecting the drivers I found that they were not very much like the Lowthers I had seen in the past. The color of the cone was now bright white instead of pale yellow and the new paper didn't seem to have the density of the old stuff. The whizzer cone was shorter and the suspension was rock hard compared to the very compliant suspension Lowthers usually had.



These speakers did sound like Lowthers, but real bad ones. A little experimenting soon showed that the C45 unit was a complete joke and that they sounded better with it simply disconnected. But that was not a complete cure. I took out the PM 6s, retired the boxes to shelf ends in the garage and I used the C45s as paper weights.

Later a friend built me a pair of "new" Acousta 115s for use with my salvaged PM 6s. These were not the same Acoustas shown in a previous issue of *Sound Practices* but were a slightly smaller version designed for the "C" series drivers with Feroba magnets. Results were a little better in some ways than with Accolade enclosures but not what I had expected. Four weeks of experimenting with everything rational and irrational yielded no benefit

Then one day a key event took place. The friend who built the Acoustas and I were listening to the speakers when I decided to dig that old PM 6 Mk1 out of the closet and put it into one of the Acoustas just for kicks.

Friends and Lowther Fans, the difference was remarkable! And I was not even sitting in front of the speaker, I was sitting next to it after installing the driver when my friend turned up the tunes. It was not like night and day but the old driver with the pale yellow cone and soft suspension was better sounding in every way. Clearer, more fine dynamics, better tonal balance and less aggressive. This was clearly much more of what I thought and remembered a good Lowther should sound like. The problem was, I only had one driver and mono was not my bag, sorry Vinny.

I was disappointed and confused over the driver issue and knew Lowther themselves would be of no help, so I put the Acoustas in the garage for a while and again searched for something else to listen to.

Quite some time later I decided to give the Lowthers another try, partially because I had just sold my regular speakers. Upon getting them into my listening room I found that the aggressive *"smelL. A."* (I can say that because I was born there) air had taken its toll on the foam surround.

Curiously the older PM 6 Mk1s suspension was still in good shape.

I tried calling the German distributor for Lowther in Berlin in order to get some replacement cones only to find out that they too had thrown in the towel. For reasons of my own more or less outlined in fact # 4, I refused to even attempt dealing directly with Lowther. More phone calls to friends in Germany revealed that a company by the name of Audio Technik in Bad Salzuflen had taken over the German distributorship, so I got their number and gave them a call.

This marked the second key event in my Lowther history.

I spoke to the owner, Mr. Dieter Kirchhoff, and ordered some replacement cones. In the ensuing conversation which lasted about an hour, I learned more about Lowther drivers than in all the previous years from all sources combined. In the

meantime I've spent at least the cost of a pair of PM 4s on overseas calls gathering all the information I could.

I learned that if there is one person who could potentially write the definitive book on Lowther drivers, it is Dieter Kirchhoff. Having been a Lowther enthusiast for almost a quarter of a century, long before he became the German distributor, he has pretty much seen and heard it all. He personally knew Donald Chave, principal designer of all drive units for many years, whom he visited in England on several occasions.

I knew from the experiences outlined above and from talking to other Lowther enthusiasts in Europe that there were quite a few variables associated with Lowther drivers. Dieter was able to explain to me what they were. He taught me all about voice coils, cone types, frames, magnets and driver break-in.as discussed below in the "Techno Stuff" section.

Audio Technik sells two types of Lowther drivers, the standard current production units as they arrive from England (within reason, of course) and what they call the "A.T. Special " line.

A.T. Specials are slightly different than standard-issue Lowther drivers. Mr. Roy Hopps and Dieter put together a list of 26 items which differentiate an A.T. Special from standard Lowther production units. A.T. Specials have the best cones, voice coils, least amount of glue, best magnets, they're aligned perfectly, and they have NO Hi Ferric applied. You can't do any better! But you'll have to pay a little more.

Needless to say the cones I received from Audio Technik were sonically a lot closer to what I expected from a Lowther driver. My faith had been restored.

TECHNO STUFF

"C" type Magnets

The Feroba type magnets are fairly consistent in actual magnet power i.e. relatively close to rated gauss specs. Ideally the magnets center piece should be flush with the outer edge of the air gap. Depending on production run, this has varied by up to 2mm plus or minus making voice coil height adjustment a little difficult because the top edge of the voice coil should be flush with the outer part of the air gap.

"A" type Magnets

The smaller Alcomax type magnets like those on the PM 6 A are not as consistent in gauss ratings, sometimes several Kgauss down from spec. On Alcomax types, the very edge of the inner voice coil should be flush with the edge of the magnets' assembly center piece, i.e. it should just be visible when looking "into" the driver. Having a longer voice coil former than Feroba units, some Alcomax units, such as the PM 2A have the pole piece chamfered so that the phase plug fits properly with respect to voice coil height (see photo). There do exist older units without the chamfering. A replacement cone for this type of magnet will have to be adjusted appropriately in height.

Voice Coils

As you probably know Lowthers have a "balanced" voice coil that is wound on the inside as well as the outside of the parchment paper type voice coil former. The whole voice coil assembly forms a mechanical filter described in "Driver Break In" below.

Much experimentation has gone into finding the optimum voice coil length. Donald Chave believed it to be somewhere between 5 mm and 6 mm. Longer voice coils make the drivers sound a bit "Slow". All A.T. Specials have a voice coil length of 4.5 mm which is what Dieter determined to be optimum. I think most standard Lowthers are currently made with 4.5 mm voice coils also.

For about three years now Lowther has been coating their voice coils with a magnetic paste they call "Hi-Ferric". It's supposed to keep the voice coils centered and increase efficiency.

I'm not so sure it really does much for the voice coil centering. In fact, it will ruin the centering if not evenly applied. It does increase efficiency, but only in a small upper mid-frequency range. And let's face it Lowther fans, the last thing a Lowther needs is more output in the mid-range!!! Worse yet the stuff doesn't seem to stay on for very long. It flakes off and gets stuck in the air gap of the magnet where it causes problems. This requires dissassembly of the driver and a good cleaning of the air gap with cellophane tape. For these reasons, A.T. Specials do NOT have coated voice coils. Draw your own conclusions about the stuff...

Here's the scoop on voice coil material: Aluminum is the traditional material, silver being offered as an expensive alternative. Donald Chave told Dieter that the only reason silver was ever used as voice coil material was for use in the Acousta 124 enclosure, also called the "Super Acousta". This folded horn was essentially an Acousta 115 with two drivers. One of the drivers was fitted with a silver voice coil, not for any special magic sonic benefit, but because of its higher mass specifically to *slow the driver down!* This reduced interference between the two drivers at higher frequencies. So again, draw your own conclusions.

The voice coils on Feroba and Alcomax units differ as follows. The distance from the top edge of the voice coil to the edge of the cone assembly is almost twice as long on Alcomax units, i.e.. the voice coil carrier on Alcomax units is much longer (see photo).

To (hopefully) clarify this a bit, an Alcomax type cone could potentially be used on a Feroba magnet if installed with spacers but a Feroba type cone CANNOT be used on an Alcomax magnet because it would not reach into the air gap.

Power handling

100 Watts?!?!?!? Well maybe for a milli second or so. Let's face it. A voice coil made to be light enough to reach far into the treble range simply cannot be made with a wire gauge able to handle 100 Watts for any length of time. Typical Lowther misinformation. Dieter says in his humorous way that: "At 100 watts the life expectancy of a Lowther is reduced from 10 to 20 years to about 5 seconds."

Driver Break-in

The voice coil former consists of a type of parchment paper chosen by Donald Chave specifically for its thinness of about 0.05 mm and for the following effect, according to his theory —As the drivers are used this parchment paper and the lacquer they are coated with literally "softens", allowing the voice coil itself to move more independently from the cone assembly at higher frequencies. It is this effect, above all others, that is responsible for the difference in sound quality of a Lowther that is broken-in and one that is not.

The cone assembly itself also experiences some softening. You can actually run your thumb nail along the voice coil of a new (non Hi Ferric) Lowther and depending on how crisp a sound you get, which is proportional to the amount of lacquer on it, you can tell if the driver will require a longer or shorter break-in time.

A fully decoupled voice coil produces two sonic effects that are not necessarily supported by measurements. First of all the drivers sound better, faster more extended and less aggressive, often described as



PM-2A (bottom) and PM6C with phase plugs removed. Note the voice coil former is almost twice as long as on the PM-2A. Notice also the chamfering on the PM-2A's center pole. 91mm is the proper size for the whizzer cones.

"silkier" in the treble range. And secondly the extreme directivity at high frequencies is somewhat reduced.

Suspension

Over the years there have been two types of suspension used on Lowthers. The proper "soft" type and the ridiculous "hard" type that was around for a good part of the 1980s. It is doubtful that any of the drivers with this hard type of suspension are still intact because it had a life expectancy of about 1/3 that of the soft type suspension.

Thanks to Dieter's efforts, the early 90s saw the return of the soft suspension and a few other things. If you find some used drivers with the hard suspension, buy them cheap for the magnets and get some new cones. The cones on hard suspension units were all wrong anyhow.

Frames

Frames have always been made out of aluminum. For a very short period sometime in the early 1970s the drivers used plastic frames. These were sonically better in some ways but just not strong enough.

About 5 or 6 years ago, Lowther switched from older style brushed aluminum frames to the stronger black painted version. This is the only change in about the last 20 years that has been generally accepted as an improvement. Some older enclosures will not readily accept the newer frame without modification, so be aware when trying to mix and match.

Cones

More than any other single element, the Lowther's cone is the predominant factor in sound quality and can make or break the drivers as to their usefulness in high quality audio. At the same time, no other part of these drivers has seen more experimentation by hobbyists and the Lowther factory.

The low point in driver quality was reached during the 1980s when the following three elements were combined to produce the worst drivers Lowther ever made, causing much dismay among enthusiasts.

1. The previously mentioned hard suspension was used causing the drivers to suffer especially in regard to resolution of fine-dynamics.

2. The cones were no longer made using the pre-1980 pale yellow paper (about the color of a manila folder) but instead were then made with a white paper that did not have the same high inner density. This 1980s white paper did not have the ability to control certain cone resonances very well and those cones sounded noticeably more aggressive.

I realize that this may alarm some people who recently bought Lowthers with "white" cones. In regard to that let me say this: to the best of my knowledge, Lowther today uses the good paper on all of the A series units However, some C series drivers have reportedly been shipped with the less desirable white paper in recent memory. It varies with the production run, as do so many other things. All AT Specials, whether A or C type use the better paper or else Dieter wouldn't sell them. Again, it is not the color that matters but the "weight" of the paper. Again, find yourself a knowledgeable dealer...

3. The whizzer cone had been shortened by a whopping 8mm!!! I think Lowther did this in response to recommendations by various publications (one no less by the prestigious *L'Audiophile*) that recommended various forms of "butchery" to the whizzer cone to achieve better measured

frequency response and to attempt to tame a resonance that occurs at about 2.5 kHz. Overall, these attempts failed in subjective listening tests when compared to mid-1970s drivers.

Dieter related an interesting story to me about some friends who tried, during weeks of eager experimentation, every possible modification known to man to the whizzer cone. They tried lengthening it, shortening it, cutting triangular patterns into it, you name it. When they brought the "optimized" drivers to Audio Technik, Dieter quickly pointed out that they had rediscovered the 91 mm whizzer cone of the mid-1970s.

According to Donald Chave there is only one correct set of parameters in regard to cone geometry that works optimally. So whether old or fresh off the line, make sure your whizzers are as close to 91 mm outer diameter as possible (see photo).

When Audio Technik was offered the German distributorship of Lowther products in 1989, Dieter asked for samples of current production units. Upon inspecting the current "State of the Art" he respectfully declined unless Lowther were willing to supply him with drivers based on the design of the 1970s, especially in regard to the cones. So after some research and the sacrifice of some older good drivers, Dieter forwarded the design information to Lowther.

Through the concerted efforts of Dieter and especially Mr. Roy Hopps, chief designer at Lowther (credit where it is due), the year 1990 saw the introduction of Lowther drive units by Audio Technik with the suffix "A.T Special" which are very similar to 1975 units. Many of the findings of this research were also incorporated into standard production models, much to the benefit of the product line.

Early 1970s cones had the very outer edge of the cone bent downward and the surround was attached to this lip instead of the cone directly. This kept the cone nice and round and offered a little more strength. Unfortunately it's been impossible to persuade Lowther to use that method again, apparently because it is rather difficult to manufacture.

As to the patterns impressed into the cones, the older diagonal is preferred. All the Alcomax drivers have the original pattern. Only the "C" series has the newer ring pattern and only on the low frequency cone. The whizzer on "Cs" still has the original pattern.

Cone trivia: Sometime in the early 80s Lowther was experimenting with PLASTIC CONES! I have photos to prove it.

The Feroba Models

The only Feroba driver recommendable is the PM 6. All the others have the large magnet problem in which sound is reflected off the magnet back through the cone. A PM 6C/A.T. Special sounds almost identical to a PM 6A/A.T. Special, the C type sounding a little bit brighter because of the shorter mechanical filter described earlier. Don't even consider the C 45 or the C 55!

The PM 7C and the PM 2C tend to sound a bit shrill and aggressive, partially due to the shorter mechanical filter, than their A type counterparts. Don't be fooled into mistaking brightness for clarity.

The Alcomax Models

The Alcomax series consists of 3 different magnets combined with various "soft" and "hard" iron pole pieces and end plates to produce the different magnet assemblies. The hard iron pole pieces concentrate more energy in the air gap for a given physical size but the soft iron pole piece, in my opinion, produce a more "linear" magnetic field.

PM 6A: Has the smallest magnet and pole piece.

PM 7A: Has the PM 6 type small magnet but has a hard iron pole piece that is able to concentrate more energy in the air gap.

PM 2A: Has a medium size magnet with PM 2 soft iron pole piece.

PM 2 MK2: This driver is no longer available. It had the same magnet as the PM 4 A with a soft iron pole piece.

PM 3A: This is a PM 2A with an attached enclosure purpose built for the TP 1 type enclosures.

PM 3/5A: This is a PM 5A with the above mentioned enclosure.

PM 4A: Has the PM 4 magnet with the biggest hard iron pole piece available. This driver was designed to be used as an indirectly radiating speaker in the Audiovector type enclosure which is why it has that "light bulb" like diffuser instead of the standard phase plug. It was never intended to be used as a direct radiator like all the other models.

PM 5A: Has the same magnet as the PM 2 A but has the hard iron pole piece of the PM 4A.



An Academy in the works.

The PM 7A currently enjoys great popularity that I don't quite understand. Dieter points out that the PM 7A is a PM 6A with a different pole piece allowing a little more of the PM 6A type magnets' energy to reach the air gap. Notice the identical weight specification for the PM 6A and PM 7A. Recent spec sheets indicate that the PM 6A has an Alcomax 2 magnet and the PM 7A has an Alcomax 3 magnet? No comment.

If you're considering buying a pair of PM 7s, you may want to invest a few more dollars and get the PM 2A. It's a much better deal. As magnet power increases so do things like high frequency extension, dynamics, voice coil control, and unfortunately a tendency of the speaker to sound aggressive and unbalanced. The PM 2A seems to strike the best compromise in this respect partially, I believe, because it has a soft iron pole piece. Time and time again, I have seen this model chosen by many enthusiasts as the best driver for direct radiating applications because it sounds the most "harmonious."

Note: The use of silver voice coils now available on all units may reduce the aggressive tendencies of some of the more powerful drivers. But this is probably due to the weight factor as pointed out earlier.



A modified Acousta cabinet in progress

It seems wiser to me to put your money into a better magnet assembly versus a "slower" voice coil to achieve this desirable effect.

What to buy used

Of the Feroba type, only the PM 6C and PM 6C MK1

Anything and everything of the Alcomax line you can find cheap but be aware that if it's from the 80s, you're buying it for the magnets. What is cheap? That's hard to say. If you have some used drivers lined up you should check to see what a replacement cone would cost for that particular unit versus the complete unit new. The rest is obvious. Stunning logic, huh?

The good thing about functional used drivers is that they're probably already broken in!

What to buy new

This, of course, depends on the intended application. Get the appropriate driver for the enclosure you plan to build.

As you can tell from what I said earlier I personally would recommend the PM 6C if you're on a budget. If it's Alcomax you want and you can afford it, get the PM 2A, my personal favorite. Other people have different opinions, what can I say?

Important: If you are not in a position to hear a set of Lowthers of any type before you buy and don't want to take it on faith, I strongly recommend that you get a pair of PM 6Cs. I am personally absolutely convinced that if you do not like the basic sonic signature and character of Lowther drivers, it won't matter what model driver or what enclosure it is, you ain't gonna like it!!! So if you have to find out through a purchase it may as well be cheap. I assure you the PM 6C has all the qualities that will let you know if Lowther is for you at a reasonable cost.

If you find that you like Lowthers, you can then consider upgrading to one of the Alcomax models. Furthermore, if you want to experiment with one of the dual driver type enclosures, you can get an Alcomax for the front and use your PM 6 Cs for the back.

FIRST AID

The following applies mainly to used drivers, of course. But if you get your drivers directly from Lowther, you should give them a thorough check up, especially with regard to voice coil centering. Lowther is really bad about that.

First check the voice coil with an Ohm



Voice coils often break at these points. This is a repairable condition.

meter. If it reads open,the coil is either fried or the unit has the following typical Lowther problem: When Lowther attaches the aluminum voice coil wire to the litz wire going to the binding posts, they often put too much tension on the coil wire. Eventually this causes the wire to break at that point. Especially if the drivers are stored in a place with varying temperatures, like a garage. I know this because its happened to me. Although very tricky this is repairable (Dieter does it all the time). First you must find out where the wire is broken and then you will have to use a special solder for the repair. It is best regarded as a job for your Lowther dealer or someone who's done it before.

A case in point: A friend of mine in France had 8 new drivers stored for 8 years. When he unpacked them recently to complete the "temporarily" shelved project ALL EIGHT drivers' coils measured open. Yes he was extremely bummed!!!

As I said earlier any thing from the 80s which has the hard suspension and/or the short whizzer, and/or the white paper cones, the cones should be replaced. If the drivers are functional, certainly you can go ahead and use them, just know this is not how it was intended to be.

If you found some drivers that appear to be in O.K. shape, and not from the crap vintage, inspect the whizzer cone for any evidence of butchery which unfortunately is quite common. It should have a measured outer diameter of about 91 mm (see Photo).

Next check to see that the voice coil is centered properly. Press down carefully and evenly onto the whizzer cone with thumb and index finger of both hands. Listen and feel for any resistance or scratching. If any resistance or scratching is present, proceed as follows. Loosen the bolts attaching the frame assembly to the magnet just enough so you can move the frame independently from the magnet. If you have a function generator set it to 20 Hz and give it enough voltage to get the cone to move a few mm. If you get a lot of scratching, use common sense and back off!

Carefully move the frame relative to the magnet until you can turn the generator voltage up far enough to get a good 2 to 3mm of excursion in either direction without any interference to the voice coil. But this is only a starting point. If left here, there is a good chance that the voice coil may be very close to a side of the air gap. When the driver is installed the weight of the magnet can produce enough distortion of the frame to again cause interference.

The careful pushing on the cone method introduces enough "slop" to reduce the chance of this happening. So now go back and do the pushing test again. If the voice coil scratches, do the re-adjust again and check by hand until it runs free. This takes time and practice. Re-tighten the bolts carefully and evenly.

If you can't get the voice coil to run free after several attempts, there's probably something in the air gap that will have to be removed. This is especially likely if you have a Hi Ferric driver.

In this case the frame/cone assembly will have to be removed and the air gap cleaned with tape. As always, use extreme caution during this procedure. Completely remove all bolts before carefully lifting the frame from the magnet.

Should you decide you need a new cone for any reason, it would be wise to remove it from the driver and measure the distance from the edge of the voice coil to the cone assembly. This information may help you or your dealer in getting the best possible replacement unit. If you can't get an exact duplicate, at least you'll know if shimming for proper voice coil alignment is an option. This, by the way, is a common practice.

Repairing minor foam surround damage is possible. I like window silicone the best because I can paint it on very thin with a small paint brush and it has very little effect on the suspension's compliance. Of course, you have to thinly coat the complete surround and spider on both sides. The spider on Lowthers is also made of foam and siliconing it properly will require disassembly of the driver.

Is it really worth fixing an old driver? Well yes, if it's one from the 70s. And furthermore its going to be about as broken in as it will ever get! Besides what have you got to lose?

ENCLOSURES AND WHAT TO EXPECT

This chapter really requires a separate article because there's so much that could be said. But here are a few brief thoughts. The powerful magnets needed to overcome inertia for high frequency reproduction tend to reduce low frequency response. It is also necessary to keep cone excursion down as low as possible to prevent doppler distortion. For these reasons, Lowthers are generally fitted to some type of rear loading bass horn that augments the frequencies below 300 Hz or so.

In my opinion, these horns are a blessing as much as they are a curse. I've been doing quite a bit of work on alternate horn designs for Lowthers as well a some non-horn designs. Assuming there is any interest and I don't get shot by some "Lowther Cultist" for saying some of the things I have so far, I might publish some of my findings in a future issue of *Sound Practices. [Heck, send in the manuscript even if you do get shot. We'll do posthumous articles--ed.]*

I separate the enclosures into 3 basic types:

1) The *Acousta-type* free-standing horns. These are front-firing and are somewhat less critical in room placement than the Bicor type. These are the Mini Acousta 109, the standard Acousta 115 the "new" Acousta 115 and the Super Acousta 124 which uses 2 drivers.

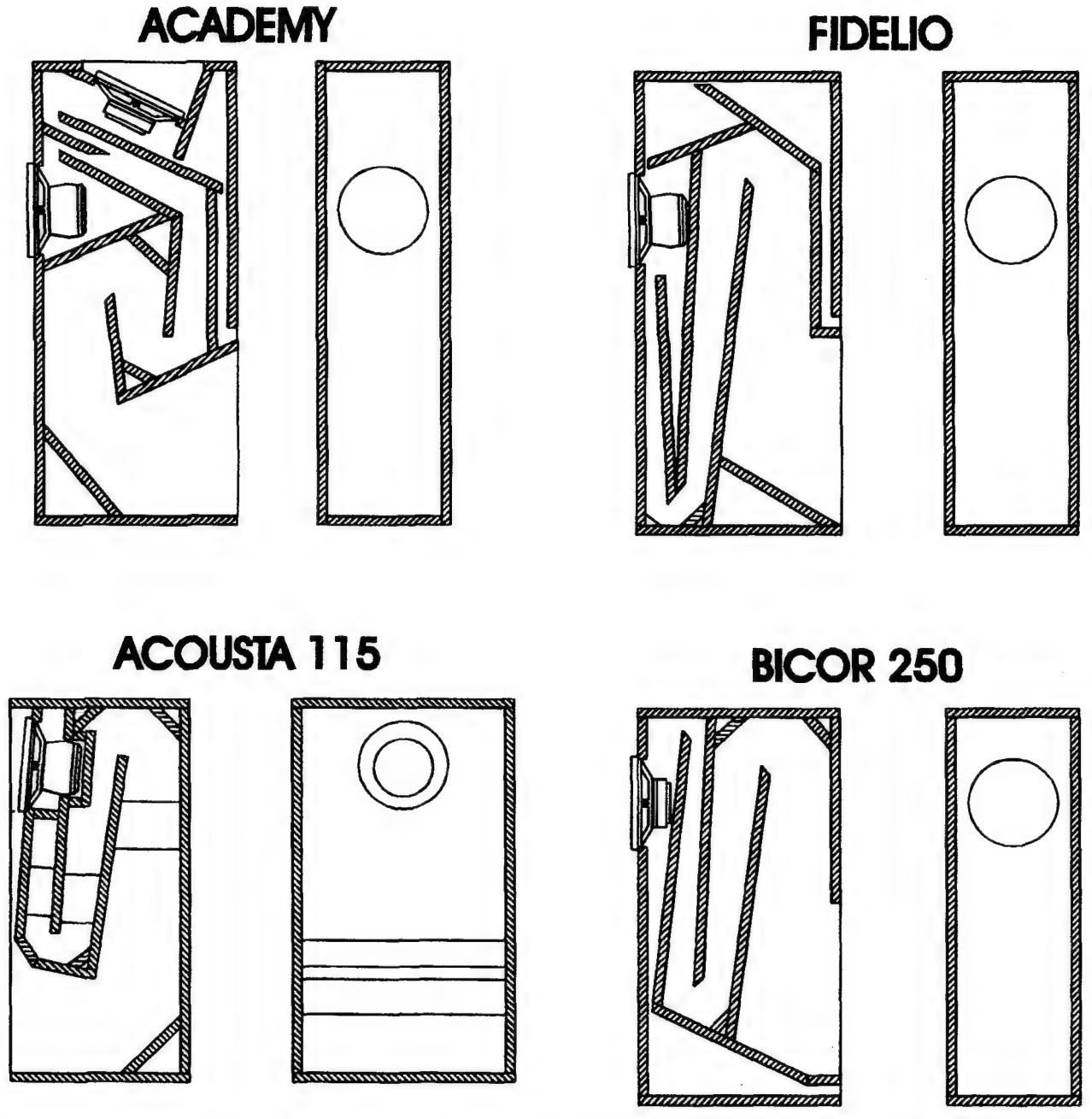
2) The *Bicor-type* enclosures which are rear firing and must be placed to some degree close to the back wall of the listening room. This family of enclosures includes the Bicor 200, the Bicor 250, the Fidelio, and the Belcanto. The models that use 2 drivers are the Bicor 2000, the Academy, the Delphic and the Delphic 500. (The Delphic 500 is not really a bicor, since it does not have a "bicor column.")

3) The *large corner horns* like the Opus I and the TP1 which don't always sound as well as may be expected. Let's stuff Ricky Lee Jones tightly into a corner and see what she sounds like, shall we?

And then there's the Audiovector, Dieter's favorite, which is sort of in a category of its own. This is a VERY large semi free standing horn that uses the PM 4A driver firing upward onto a reflector. Some versions (there are 4 types) also use a PM 2A firing directly. There are probably a lot more enclosures than those mentioned above, but these I know and have the plans for.

So lets have a look at the beloved Acousta 115. This is truly the classic Lowther folded horn. And its got that "Vintage Appeal". The interesting thing is that this enclosure according to Donald Chave is not one of their originals at all!!! Lowther at some time back in the dark ages took the plans from some other speaker and adapted them for use with the PM 6 driver.

There are two things that support this theory. First of all the throat area of this horn



Acousta 115 shown with some newer Lowther "Bicor" designs. Note the narrower baffle width on the new designs

is about 110 cm^2. Just about all other Lowther designs I have seen provide the driver with about 50 to 60 cm^2 of throat area. Which is more appropriate for a driver of this size. In fact if you take a close look at the throat area you can see that it really looks like a hack job with a very uneven transition from compression chamber to throat. This is not Lowthers' style because in spite of many of their faults Lowther does an incredible job of folding their horns. The Super Acousta 124 with two drivers in the same horn provides a better loading.

Secondly, there's that funky magnet box. Look at any other Lowther horn, including the Mini Acousta 109 and you'll see that they generally do a much better job of accommodating the driver's magnet than with a magnet box!

The Acoustas I just built for myself eliminate both problems. They have no magnet box and the throat is 20 cm longer and tapers down to an area of 60 cm^2 (see photo). This horn was built to accommodate the PM 2A/A.T. Specials that I have. Not having an original for comparison I can't say whether it works any better though.

The Acousta's major drawback is its large baffle size. There are a lot of reflections and secondary radiation coming off the baffle that cause some problems and because of this it sounds best at a listening distance of 4 meters or more. Notice that almost all current Lowther speakers have cabinet widths not much greater than the driver itself. The Acousta's big plus is that with minor adjustments to the magnet box it will take any of the Alcomax drivers up to a PM 2A.

The Bicor line are very narrow enclosures. This eliminates many of the problems associated with the large baffle of the

Acousta. They consist of a small folded horn that fires out toward the back. There is also a second "air column" basically in parallel with the horn that terminates in a small vent next to the horn mouth. Lowther claims it eliminates standing waves. Most of the Bicor horns will only take Feroba-type drivers which they were designed for. The single driver Fidelio will take a PM 2A and the two driver Academy will take a PM 2A in the front position and a PM 6C in the rear.

Dieter says that with this driver combination, the Academy is one of the best sounding cabinets going and he sells a lot of them. He also says that where the Acousta has a tendency to "scream" at you the Academy will "sing" to you.

In spite of being a little suspect of the twin driver concept, I built a pair of Academys with a PM 2A/A.T. Special up front and a PM 6C/A.T. Special as the rear driver and compared them to my Acoustas. In my opinion there is NO comparison. The improvements offered by the Academy in every respect, including far better bass in my listening room, are so staggering that thoughts I had of correcting some of the Acousta's shortcomings no longer seem that interesting.

The Fidelio is more or less the single driver version of the Academy and I would build this enclosure before I build another Acousta. It is very popular in Europe right now.

Of the large horns, Dieter considers the Audiovector to be the sonic flagship. It uses the PM 4A rear-loaded into a long bass horn and front-loaded into a midrange horn which fires up against a reflector. This virtually eliminates the unpleasant effects normally associated with the extreme directivity of Lowthers. It can use an additional PM 2A firing directly forward. This driver is attenuated quite a bit in relationship to the PM 4A and it should be run from a separate amplifier with proper attenuation.

I think the large horns should not be considered by Lowther neophytes. They're very ambitious and expensive projects that are difficult to build. It would be wise to start small and graduate to something like an Audiovector.

Unless you're going to get a super high grade (and super expensive) plywood like the Europeans like to use, such as Finland Birch or Multiplex, I would generally recommend MDF for cabinet construction.



Audiovector

There's no substitute for mass. Think about it, if you build an Acousta from some of that super strong and light alloy stuff they recovered from the Roswell U.F.O. crash and it weighed only 5 lbs what would it sound like?[*That Roswell stuff is good for tonearms too- ed.*] Standard plywood may have reasonable strength, but it doesn't have enough mass.

Contrary to what you may have heard the compression chambers of ALL cabinets should have some damping material in them to absorb higher frequencies so they don't reflect back through the cone. Hold a piece of Manila folder (similar to Lowther cones) tightly up to your speakers and see how much sound makes it through. Enough said.

As to the sound you can expect, let me quote my friend Peter Clark who stopped by while I was writing this article to hear my altered Acoustas with the PM 2A/A.T. Specials. After a few minutes of Rare Silk, on vinyl of course, he said:

"They really don't have a lot of bass but man that's the fastest darn thing I've ever heard"!!! And he hasn't even heard my Academys yet!

And fast they are indeed, extremely so. The response to the attack as well as the decay of transient information is absolutely phenomenal. In my opinion, this is Lowthers' greatest strength. These drivers produce a level of midrange clarity, detail, dynamic contrast and liveliness that is just incredible.

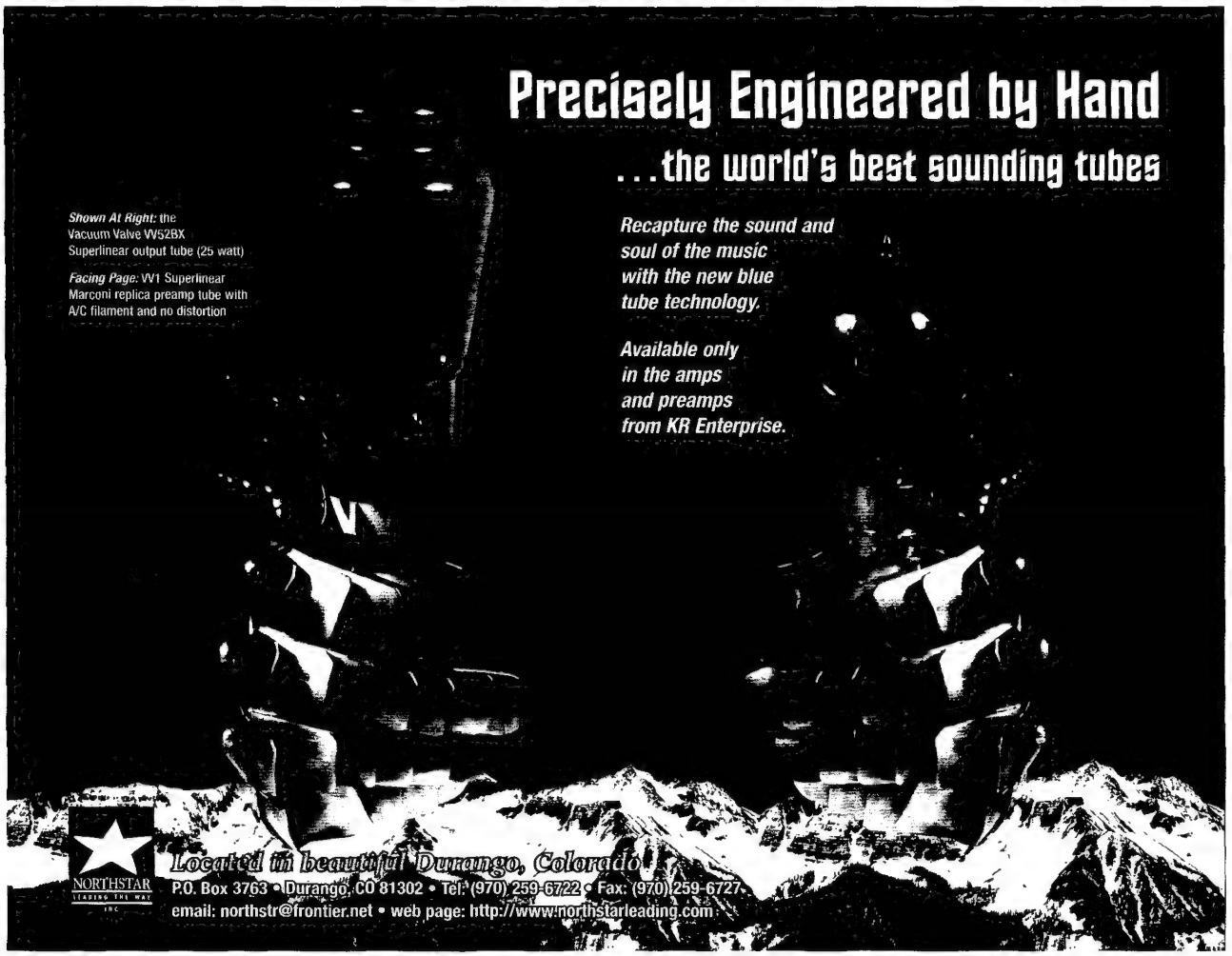
The PM 6C does sound a bit rolled off but not enough to be bothersome to me. Years of riding loud motorcycles has reduced my ears "top end response" to about 14.7 KHz. On the other hand the PM 2A plays with a clarity in the top registers that makes any thought of a super tweeter fade quickly. At the same time the sound can take on a somewhat aggressive quality depending on the specific driver and enclosure used and the listening distance. This is due partially to the 2.5 kHz cone resonance described earlier and the extreme beaming at higher frequencies. But you will find that you don't need to turn Lowthers up as far to get the message. All the fine dynamics and detail are there even at relatively low listening levels.

Lowthers can play LOUD. One slip of the volume control and your ear drums will meet in the center of your head!!! And they'll do it with just a few single ended watts.

In his must read book, *The Tube Preamp Cookbook*, Allen Wright makes a statement that I find profound and agree with wholeheartedly. He says, "The ability to accurately reproduce low level information in the presence of other stronger signals is one of, if not *the* most vital property of really good audio gear!" And Lowthers do this sooo well.

So what about the bass you ask? Well J. C. Morrison wrote in one of his articles that no amplifier plays perfectly over 10 octaves. And Lowthers don't either. Lowthers are undoubtedly bass challenged regardless of driver model or enclosure type. The bass they have is bone dry, swift and punchy. But there's just not very much of it and it really doesn't go all that low. Things really start slacking off in the lower mid-bass area and if you're used to the grunt of 15" cobalt powered Tannoys like me, its the only thing you're going to miss.

Of course it depends very much on the listening room. None of the enclosures couple well to a large room. Measurements of a well placed Acousta indicate response down to 50 Hz. Subjectively speaking, I feel that things start getting a bit thin at about 100 Hz or so. The Lowthers bass shyness has sparked many designs in which these drivers were liberated from frequencies below 200 Hz to 300 Hz or so by using a 12" or 15" woofer for the low end. One design as I recall even suggested a Karlson coupler!



I know Lowther fans don't want to hear this but if you want bass extension to complement the Lowthers' spectacular midrange and top, there's simply no getting around using some kind of subwoofer. The problem is finding one that can match the speed of a Lowther. In applications where a subwoofer is desired, Dieter uses nothing less than a Klipschorn actively coupled at 70 Hz. He thinks that it is the only bass speaker that can keep up with Lowthers' speed.

So there you have it. I could have said twice as much and still not have finished my say but all things must come to an end.

Lowthers (good ones) have a unique quality which is entirely their own. They don't appeal to everyone but after reading this you may be closer to knowing if they're for you. If you've been contemplating using Lowthers in your system I hope that you'll now be a little better equipped to make the best choice for yourself. If you get good examples of these drivers, break them in, and use them properly I'm sure you'll derive a great amount of listening pleasure out of them just as I have.

For questions, comments (I have a feeling I'll get a lot of those) corrections or just basic exchange of ideas I can be reached at E-mail : darmah@ goodnet.com Phone: 520-776-5996 Arizona time please! Fax : 520-776-5994

If you want to talk to real Lowther expert, Mr. Dieter Kirchhoff at Audio Technik in Germany, can be reached at 011-49-5222-3096 (voice phone) Make appropriate allowances for local time difference.

Editors note:
When I first got hip to Lowthers some years ago, I thought that something like a PM6A in an Acousta box would be a great sensible system for tube lovers. And my PM6As in Medallion-style Acoustas are just that for me. Natural sound, simple, reasonable size, medium cost, play loud on low power, intriguing whizzer cone design, I'm quite satisfied with the PM6A Medallion combo. Even though it doesn't have the presence and scale of a 300 lb. horn system, it's no slouch for the size and price.

Little did I appreciate early on that Lowther attracts a wildly diverse, ultra-hardcore crowd beyond anything else in audio. Five articles like Mark's fine essay above would only scratch the surface of what has been done and could be done with Voigt's twin-cone loudspeaker design.

One thing to mention counter to much cult lore about Lowthers is that these things work great with big tube amps too. They seem to come alive with the added power. Somehow it got implanted in many minds that you *have to use a small amp* with Lowthers because they are so efficient. I say try 'em with a pair of 6550s.

Feedback amps really help control the low end, although they *will* play on flea-powered NFB amps. I did find that some otherwise fine amps, like my 45 SE 2 watter, just didn't cut it on the Lowthers. You got to try it out to know for sure, as usual.

Measure Audio Harmonics the Easy Way



by Larry Lisle

Designing, building and tweaking audio amplifiers can be a lot of fun. It can also be very frustrating unless you measure the effect of design changes or parts substitutions. In this article I'll show you an easy way to measure one of the most importantcharacteristics of an amplifier, distortion caused by harmonics in the second, third, fourth and higher orders in the middle frequency range.

Every audio amplifier adds some distortion to the signal it amplifies. One type of distortion that's especially important is harmonic distortion. For example, if the input signal is 500 Hz, the output may also contain signals at multiples of 500 Hz, such as 1000, 1500, 2000, 2500 Hz and so on in addition to the fundamental frequency of 500 Hz. The relative strength of these harmonics to the fundamental and to each other can completely change the sound of the music amplified by the system.

There are many ways of measuring harmonics. One popular method cancels the fundamental with a null circuit and gives a value for what's left as total harmonic distortion or THD. This is useful but doesn't tell anything about the individual harmonics.

Other methods employ tunable filters and are tuned from harmonic to harmonic with the value of each being recorded. These devices are popularly called wave analyzers and tend to be very expensive.

My solution is to use a single, very sharp audio filter intended for ham radio operators for code reception. The better ones will give selectivity of 60 dB down at an octave away from the fundamental. Set the filter to a particular frequency such as 1000 Hz and tune the signal generator to submultiples of that frequency. The voltage passing through the filter will therefore be a harmonic of the input.

This method will measure distortion very accurately in the middle frequency range and give a good picture of the 'sound' of the amplifier. Of course the signal generator has to be relatively free of harmonics and its output and the voltage gain of the amp under test have to be uniform over the middle of the audio spectrum, but these are easily checked.

The equipment needed can often be found used at electronic flea markets. Older tube type gear is often dirt cheap. The signal generator shown cost $25 and the audio voltmeter cost $5. These two items are basic if you're going to do much work with audio. The prices are not unusual. The Autek audio filter cost $25. Some audio filters are tunable over a limited range but since the gain isn't constant they should be set at one frequency as described in the procedure outlined below. The only home-built item needed is the 50,000-ohm potentiometer on a board which is used to set the meter to a convenient value, such as 1.00 volt, and keep the audio filter from running out of head room.

To measure harmonics I use the following procedures, which will take longer to read than it will to make the actual measurements:

1. Measure the input voltage to the amplifier when used in its normal way.

2. Connect a dummy load with non-inductive resistors to the output of the amplifier.

3. Connect the outside contacts of the potentiometer across thedummy load.

4. Connect the input of the audio filter to the wiper contact and one end contact of the potentiometer.

5. Connect the voltmeter to the output of the audio filter.

6. Connect the signal generator to the input of the amplifier. Set the output voltage of the generator to a value determined in 1 above.

7. Set the frequency of the generator to the frequency of the audio filter, for example 1000 Hz. Rock the frequency back and forth slightly to make sure it's at the peak of the filter response curve.

8. Use the potentiometer to set the output of the filter to exactly 1.00-volt or some other convenient value.

9. Without touching the audio filter or potentiometer tune the signal generator to 500 Hz and again rock the frequency slightly to be sure you're on the peak. The output voltage will give the amount of second harmonic distortion. For example, if the reading is .003-volt, .003 divided by 1.00 equals 3/10 of one-percent.

10. Now tune the generator to 333 Hz and take a reading. This is the third harmonic and may be greater or less than the second, depending on the design of the amplifier.

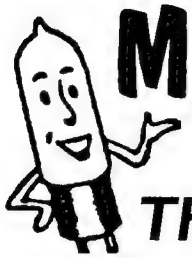
11. Other readings may be taken at 250 Hz for the fourth harmonic, 200 Hz for the fifth and so on, but the values for the second and third are the most significant.

Notice that the calibration of the signal generator and voltmeter doesn't need to be highly accurate in absolute terms, which makes this an ideal method for used or even home-built equipment.

With this method you'll really be able to see and hear the effects as you tweak your amp toward your ideal sound.



An audio signal generator, audio filter, and audio voltmeter can tell you a lot about how your amplifier is working. The potentiometer is used to set the meter scale.



Meet The Tube

The elusive TYPE 50

Until its purchase of Victor Talking machine factory in 1929, RCA was only a sales organization for General Electric and Westinghouse radio products made to its specifications. The two manufacturing companies could engineer and propose new designs, but RCA had final say on marketing any new tubes or equipment. Because of patent cross-licensing among GE, RCA, Westinghouse, and (for commercial use only, no sales to the general public) Western Electric, RCA had a virtual monopoly on tube designs. As a rule, the smaller independent tube manufacturers would only produce what RCA standardized. Most radio makers would use nothing else anyway.

During the late 1920s, more and more radios incorporated electrodynamic speakers in order to satisfy the public demand for boom-boom bass power. However, only one tube was suitable to drive these new speakers, the GE designed 10 which was limited to 1.5 watts output. The 10 used a thoriated tungsten filament as was common in tubes of the day.

Westinghouse engineers substituted a more efficient oxide cathode and managed to get 10 Watts from a tube of roughly the same dimensions and heater power. RCA began offering the 50 in early 1928.

The 50 enjoyed a short vogue until the advent of the 45 tube in 1929. A push pull pair of 45s would deliver the same power as a 50, enough for any radio in the average home, plus it required a far cheaper rectifier and filter system since it ran on 250 Volts instead of 450 and a smaller output transformer was required. In an internal company report in March 1929, GE engineers snickered at the 50 and distanced themselves from it. The 50 lingered in commercial service for a while but by 1930 it was gone from home radios. Not surprisingly then, 50s have never been easy to find – modern claims of wonderous performance are based on a scarcity of samples and abundance of wishful thinking.

Alan Douglas

RCA Cunningham Radiotron RADIO TUBES

50

RCA-50

POWER AMPLIFIER

Filament		Coated			
Voltage		7.5			a-c or d-c volts
Current		1.25			amp.
Direct Interelectrode Capacitances:					
Grid to Plate		7.1			µµf
Grid to Filament		4.2			µµf
Plate to Filament		3.4			µµf
Maximum Overall Length					6-1/4"
Maximum Diameter					2-7/16"
Bulb					ST-19
Base					Med. 4-Pin Bay.
Pin 1-Filament					Pin 3-Grid
Pin 2-Plate					Pin 4-Filament

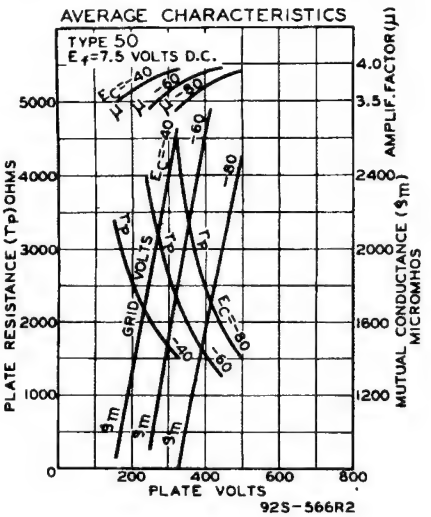
BOTTOM VIEW

AMPLIFIER (Class A)

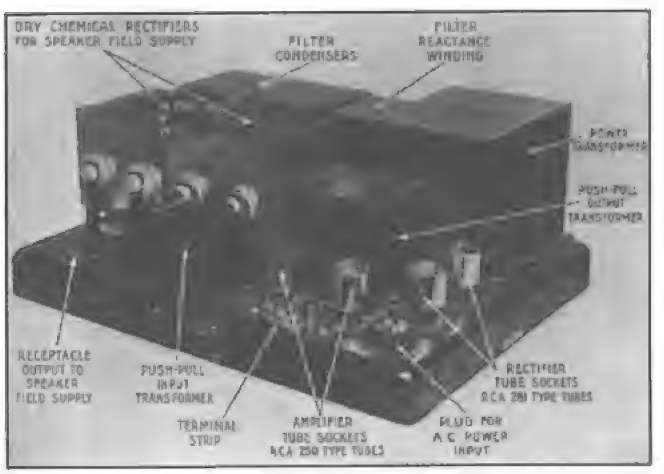
Operating Conditions and Characteristics:					
Filament	7.5	7.5	7.5	7.5	a-c volts
Plate	300	350	400	450 max.	volts
Grid *	-54	-63	-70	-84	volts
Amp. Fact.	3.8	3.8	3.8	3.8	
Plate Res.	2000	1900	1800	1800	ohms
Mut. Cond.	1900	2000	2100	2100	µmhos
Plate Cur.	35	45	55	55	ma.
Load Res.	4600	4100	3670	4350	ohms
U.P.O.	1.6	2.4	3.4	4.6	watts

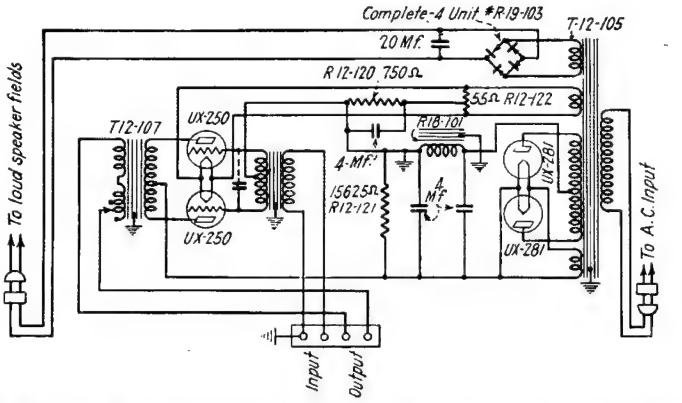
Self-bias is advisable in all cases. The resistance in the grid-coupling circuit should not exceed 10000 ohms.

* Grid volts measured from mid-point of a-c operated filament.



JULY 1, 1935 RCA RADIOTRON DIVISION RCA MANUFACTURING COMPANY, INC. DATA





RCA PK-1 Photophone theater amplifier from the early 1930s. The PK-1 features a step-up transformer at the input and one stage of push-pull amplification employing a pair of UX-250s

An Excerpt from

Tube Lore

A Reference for Users and Collectors

by Ludwell Sibley

Tube User's Guide

Electronics restorer-collectors and audio enthusiasts are rather intimately involved with tubes. The following ideas may prove helpful in preserving and enjoying classic equipment.

THINK TWICE BEFORE REPLACING

It's surprising how rarely trouble in a piece of old gear derives from a bad tube. Even though tube makers in the old days promoted routine replacements of tubes, and even though radio repairmen got a major part of their profits from sales of tubes, the tubes in an old set are quite likely to be usable.(The main exceptions are audio power tubes, which have often at the ends of their lives, and 35Z5s, which commonly have the heater section between Pins 2 and 3 burned out.) Corroded-open inductors, leaky or dried-out capacitors, partly open resistors, and similar troubles are far more likely to be present - and it's a rare set that has only one trouble. Before replacing a tube, consider the following factors.

Loose Base. A tube may be loose from its base. This has no effect on performance, but there is some risk of the bulb twisting around enough for the wires to short-circuit in the base. Recementing (see below) is all that's needed.

Rattles. Bits of loose cement in the base have no effect on the operation of the tube. Likewise with glass particles inside the tube: as long as the vacuum is OK, bits of glass from the "press" are harmless.

Loose metal parts like getters, are more serious: there is a risk of their falling into other elements and causing a short circuit.

Occasionally a large filament-type tube like a 5U4 or 2A3 has rectangular white flakes of filament coating loose in the bulb. This is suspicious, and calls for a test of emission.

Blue Glow. Tubes filled with gas (0C3, 0Z4G, 2A4G, etc.) or mercury vapor (82, 83, etc.) glow in vivid colors in normal use; lack of glow indicates failure. Some healthy power tubes (6CA7/EL34, etc.) show a small area of blue inside the glass at the top, the result of stray electrons striking the glass. However, blue glow inside the elements of a vacuum-type tube indicates a gassy tube which had better be replaced.

One Side Bad. Duodiode-triodes (75, 6Q7, 12AT6, etc.) often show weak emission on one or both diodes. This diode is only a detector; it's not worked hard, and most radios have the two diodes wired in parallel anyway.

Here is a fine case not to replace unless a new tube produces improved volume. The same goes for pentagrid converters (6A7, 6A8, 12BE6, etc.), in which the oscillator section commonly tests weak. If the oscillator works on all bands, at both ends of the dial, it's OK. (For a more refined test, reduce the line voltage 10% with a Variac.)

Full-wave rectifiers often show imbalance between the sides, in a radio which performs satisfactorily.

TESTERS AND TESTING

People naturally like to delegate hard "go - no go" decisions to a machine, but a tube tester is simply a guide to the usefulness of a tube. In earlier times it it was a handy sales tool, a scientific-appearing device helping convince the customer that a new tube was required. The "emission" type of tester checks for gross defects like failed emission - the usual problem with old-time tubes - and for interelectrode leakage. The "transconductance" type of tester is more refined, and usually tests for gas as well. Regardless of type, a tester may "fail" a usable tube or pass a defective one. Any tester in use today is at least 20 years old, and its components have aged appreciably - "5%" composition resistors, for example, have almost universally aged upward, out of tolerance. The tester may not really simulate reality - a TV sweep tube may test "OK" for emission, yet fail miserably in a linear amplifier that works the tube harder than the tester. Because individual tester designs apply different test parameters, a given tube routinely yields different readings from one tester to another.

The message: use one tester consistently, rely on it to catch the gross defects (leakage, gas, burnouts), but expect it to give no more than relative ratings of tube quality. There is no other place in electronics where keep-or-replace decisions were commonly made, based on a drift-prone analog instrument lacking even a calibration control!

Certain expensive 2.5-volt tubes (the 45 and 2A3) draw multiple amps of filament current from the tester. Before placing too much faith in the meter reading, it is wise to be sure the filament voltage is close to 2.5 volts under load - just put the probes of a digital meter on pins 1 and 4 of any of the unused sockets. The voltage often sags to 2.1 or so, guaranteeing a low reading. This is partly a fault, the result of using an inexpensive transformer. It is also partly a virtue, answering the need for current-limiting at times when the user sets up the tester to apply heater voltage to an internal jumper in the tube! Bottom-of-the-line testers may supply "2.5" volts, but don't even give setup data to test 2A3s - and test 5U4s at 4.6 volts.

The test instructions can be screwy, too. Example: on the Heathkit IT-17 and -21 testers (the best of the kit emission checkers), the test instructions for a 199 tube call for a filament voltage of 2.5 (vs. a proper 3.3). This lets only unusually good tubes read "OK." Turn the voltage up to 3.15, and the tube perks up considerably. The use of 2.5 V is probably a carryover from earlier models that lacked the 3.15-V setting.

FURTHER TUBE SCOOP

Multiple-Numbered Types. Far too many tubes carry multiple numbers, as the result of prototypes that were only triflingly different. Early examples were the 35/51, 39/44, and 47/PZ. Toward the end of the tube era this effect mushroomed. Thus, the owner of a 6BS8 automatically has a 6BQ7A and a 6BZ7. The best defense against this confusion is a tube-substitution book.

Improved Versions of Tubes. An "A" or "B" version of a tube is improved over the basic model, and will replace it (except for some Western Electric tubes which are incompatible from "A" to "B"). However, many "A" versions of the mid-'50s are improved only in that they warm up in a controlled length of time. This is important in series-string TV sets but meaningless in parallel-wired equipment. Some such types are:

6AM8A 6AU6A 6BK7B 6CL8A
6U8A 6AN8A 6AU8A 6BR8A
6CG8A 12AZ7A 6AQ5A 6S4A
6AW8A 6SN7GTB 6CB6A 6T8A
12BH7A 6AT8A 6BA8A 12BY7A

Improvements in other types may or may not matter, depending on the use: The 6AF4A is simply shortened physically; the 12AU7A is a low-microphonics type; the 12AX7A is a low-noise-low-hum variant.

Interchangeability Between Makers. In North America, the land of interchangable parts, the tube industry was blessed with uniform standards. Makers produced tube parts and complete tubes for branding and sale by their competitors. An 80 made by RCA can be replaced confidently by one from Arcturus, GE, Sylvania, etc. This seems obvious, but the writer has seen an old-timer insisting that the only feasible replacement for his blackened National Union ripply-plate 80 was another NU.

Military Tubes. There are numerous ex-military tubes around. These lack prestige to some degree, having once been sold off as "war surplus" at low prices. However, they had to meet rigid requirements (at the time, the MIL-1-A series of specifications) and are a higher-quality product than ordinary civilian tubes. They are thus perfectly good for radio-electronic restoration, and carry some cachet in the tube-audio world. The military departments are still selling excess tubes in lots of thousands, so this source has not dried up.

Early Metal Tubes. Plain black metal tubes carrying steel-stamped brands and type numbers date from the first production in 1934-35. Looking like engraving, the stamping appears mainly on RCA-Cunningham and Raytheon tubes: the "original nine" (5W4, 6A8, 6C5, 6F5, 6F6, 6H6, 6J7, 6K7, 6L7) and the 6X5. Tubes in this style are "correct" replacements for 1935-season radios like the Atwater Kent 317 or GE A-81; by contrast,they are not really right in a later set. Metal tubes with a protruding "getter bump" on the shell just above the header are early, dating pre-1936-38. Grid-cap types (6K7, etc.) having brown insulation under the grid cap are of pre-war vintage. Those with the type number steel-stamped into the bottom of the shell are from 1945 or later.

"MR" Tubes. Many old tubes are stamped "MR." These came from a 1943-45 program of manufacturing a few popular types for "maintenance and repair" of civilian radios, thus reducing a crippling shortage caused by WW II military needs.

"T9" Oldies. Interesting tubular replacement tubes appeared in the '50s: T9-bulbed versions of the 27, 37, 41, 80, 84, and 25Z5. They were a useful simplification to makers: put a 6K6GT bulb on a six-pin base, and a 41 results; put a 5Y3GT bulb on a four-pin base, and get an 80. It is easy to overlook these today because of their GT-sized cartons.

Substitutions. The beginning tube substituter can get good guidance from the wartime booklets produced by the tube manufacturers, or any edition of the Howard W. Sams substitution guide (still in print). There has been some wild substitution advice in the tube-audio world ("replace a 47 with an 814"), but the old-time sources are reliable. Speaking of substitutions: the little known industrial 5R4GY is a dandy plug-and-play replacement for the 5Y3G; it draws no more filament current, but has bigger plates and runs cooler.

Making Your Own. Many otherwise uninteresting tubes can be made into useful types by making an adapter. Equipment restorers are unnecessarily reluctant to make adapters, perhaps out of simple unfamiliarity, yet this was routine stuff in the tube shortage of WW II. For example, the 7591A audio tube is now scarce and pricey. The 7868 is common and the 6GM5 is more or less an orphan. Yet these are electrically the same - quite fit for use with adapters.

Changing or rewiring the base can work fine. As an example, consider the 6A4/LA: a 6.3-V filament-type five-pin power tetrode used in 1931 Motorola car radios. A lot of these have survived as new-old-stock, being useless anywhere else. The 6A4 becomes a good replacement for the 201A by changing from a five-pin to a four-pin base, triode-connecting the tube. At five volts, it draws the 201A's 250 mA and has ample emission. An Atwater Kent 35 plays nicely with six rebaseed 6A4s.

Rectifiers, which usually involve only four leads, are particularly easy to re-base. Some handy conversions among electrically identical (or better) types:

5R4GY to 80
5U4G to 5Z3
5Y3GT to 5Y4GT
5U4G to 5X4G
5V4G to 83-V
5Y3GT to 80

What You See Is (?) What You Get. In inspecting flea-market tubes, it is helpful to verify that the tube in the box matches the brand and type on the carton. However, RCA tubes are a special case: new-old-stock with the "new" (1969) logo often appears in cartons with the "old" logo. RCA must have had a large stock of obsolete boxes when the corporate symbol was redesigned. A variant tube should match the box - a "12AU7A" box should contain a 12AU7A - but the writer has seen a group of distributor-stock 6GT5s in 6GT5A cartons.

BUILDING A REPAIR STOCK

Restoring old equipment goes a lot easier with a good supply of "tubeware" on hand. The hints that follow will be helpful in assembling a stock for general repair use. The assumed starting point is, say, a bag of loose tubes fresh from a flea market or auction: begrimed and unknown as to condition. The rate of recovery is not bad, usually running 80-90%.

Clean-up. Inspection comes first, with filtering-out of the hopeless color-TV types. Then a wash under running water with dish detergent is effective on the grime, with a little steel-wool help on the power tubes where the dirt is baked on. Tubes should be generally be held upside down to keep water from running into the bases. Cardboard beer flats with paper towels on the bottom organize the finished product and aid drying. Tubes needing repairs get set aside for the Tube Hospital. The exception to washing is miniatures and loctals, most of which are identified with water-soluble ink. Either the brand name disappears or the tube becomes wholly anonymous. Washing should be limited to the non-inked part of the tube. The ink even smudges when handled with moist hands.

Miniatures and compactrons need a check for bent pins. A pin straightener or fingernails are the preferred tools to correct any bending. The use of pliers is likely to crack

the glass.

An important hint applies to big-pin (4-5-6-7-pin) tubes: if they've been stored outside a radio through humid summers, the heater pins may have corroded enough to give poor contact in the tester. This applies particularly to the 2.5-V types. These draw an amp or more, so a contact resistance of even 1/10 ohm will keep them from heating fully. Hand wire-brushing is insufficient. It usually is necessary to scrape the heater (big) pins vigorously with a single-edged razor blade. The same goes for loktals with their small pins: the heater pins (1 and 8) may look clean, yet be covered with an insulating film.

Testing. The game now is to speed up a basically slow task. The affordable luxury in this area is two testers of the same type. For multiple single-section tubes of the same type - 50L6s, say - the test goes left-right-left-right, warming up in one tester while reading on the other. For multiple-section tubes, each tester handles one-half of the tube.

Many testers require the user to cruise up and down the roll chart to get test instructions, and then to set up all pin connections before the heater voltage is applied. It is easy to make up a simplified card showing the setups for the most common audio and antique tubes. The setup sequence also can be changed so that the first thing set up is the heater; the tube is then warming up while the other settings are in process. This is a safe process because no known tester applies high voltage until the "test" button is pushed.

Regardless of the hardware, the idea is to group the octals together, the 7-pin miniatures, the loctals, and so on; then to bunch up tubes of the same or similar types. With the tester set up for a particular type, one can breeze through all units of that type. This idea leads immediately to grouping all types having the same pinouts, for example the 6SG7-6SH7-6SJ7-6SK7-6SS7 family or the 12AU7-12AV7-12AX7-12AY7-12AZ7 group. Here it is possible to go between types by changing only the potentiometer(s) on the tester, not the pin switches. Or one can group by heater voltage: test the 6BA6s, then do the 12BA6s by simply turning up the heater voltage. Wisdom requires testing the lowest-voltage types first, to avoid the bitterness of blowing a tube with excessive voltage. With practice, one can do a hundred mixed tubes an hour.

In the '50s, the counterman in a parts store who spent the day testing whole TV-sets-ful of tubes had a preheater: a chassis with multiple sockets wired to apply six volts to all heater pins. This shaved a few minutes off the time to check a load of tubes - not a bad idea for anyone expecting to test a lot of tubes.

Further Tests. Supplemental tests are sometimes necessary. 35Z5s and 35W4s may test "good" even when the pilot-lamp section of the heater is open. An extra check with an ohmmeter is needed on these. Big rectifiers like 5U4s that test OK may arc-over when used at full voltage; only set-testing finds these.

Mystery Tubes. Tubes of the two-digit variety may be numbered almost anywhere: on the crown, the side of the bulb, or the base. The numbers are often faint, especially on Sylvania and Philco tubes of the early '30s. Here the old repairman's trick of rubbing the tube on one's hair comes into play. The tube collects a light coat of oil, which one strokes with a finger into a microscopically thin layer. Holding the glass up to the light then reveals the number by contrast. The best test is to do this in bright sunlight, observing slowly and patiently.

With practice it becomes possible to guess the type pretty closely by inspection. (If it has a cylindrical structure with a zillion visible grids, a cap, and a seven-pin base, it's either a 2A7 or a 6A7. If it then tests OK as a 2A7, that's it.)

Storage. Boxing-up comes next. New white boxes are available from sources like Antique Electronic Supply. They sometimes appear in collector markets. Old boxes can be reused nicely by covering the type-number stamping with typist's correction tape of the 2/6" width, giving a fresh writing surface. (New-old-stock TV tubes often are auctioned off for much less than the value of their cartons.)

For storage, a cardboard box of the 11" x 17" size used for xerocopy paper can be cut down to tube-box height. It then takes 96 octals or 192 miniatures, with a convenient slip-on lid. With 3" x 10" spacers cut from old file folders to keep the rows straight, a tidy package for storage results.

To store tubes without individual boxes, cardboard beer flats can be cut down in height (to 1-"" for T9s, etc.) and the tubes laid out. The flats will stack in xerocopy paper cartons. This is not as elegant as individual cartons but definitely beats jumbling the tubes in a box.

After sorting out the first few hundred items, tubes resolve themselves into three classes: the Prized Repair Supply, the Flea-Market Sale Stock, and the Embarrassing Glut. One quickly learns the low value of most TV-set "pulls." (The 6SN7 is an "audio" type today, but how many 17D4s can you use in a lifetime?) The flea-market stock can be sold off, if the tube boxes are labeled clearly and displayed in order. Miniatures have only minor value in the collector market, but have some draw with comm-gear restorers. Six volt Compactrons have some (small) value for use in '60s amateur and audio gear.

TUBE HOSPITAL: REPAIR & REACTIVATION

In principle, tubes are not repairable, other than the rebuilding operations that are applied to big transmitting types. Still, there are numerous ways to salvage a troubled tube.

Loose Bases. To re-cement the tube, use clear nail polish - paint a ring around the base, let the polish soak into the old cement, recoat, and let dry overnight. Polystyrene "coil dope" works as well, and can be used to refill the nail-polish bottle. Solvents (acetone, etc.) are ineffective in softening the old base cement - the cement was baked hard in manufacture, and "nothing" dissolves it.

Broken Keys on Octals. These have no effect on performance but are unesthetic. Inspection will usually show where the locating rib on the key was located. If not, an ohmmeter check for the heater will reveal which pins are 2 & 7 or 7 & 8.

Key breakage is most common on big metal tubes (6L6, 5T4), whose weight stresses the key if the equipment is dropped. Fortunately, these are the easiest to repair, simply by replacing the base wafer. To do so, flex each pin carefully with pliers until the brass breaks, then unsolder the pin. Uncrimp the shell from the base wafer. Swap the wafer with a good one from a dud. With practice, this takes less than 15 minutes.

It is possible to cement new keys onto bases, but holding the key aligned until the cement (epoxy, etc.) cures is a problem. A wafer-style tube socket, pushed onto the pins upside down, makes a holding jig. Still, the key often comes out tilted.

Rebasing. Old tubes have sometimes been stored in wet locations where a pin has corroded to the point of breaking - the brass was cold-worked heavily in fabrica-

tion, and is sensitive to chemical contamination.

High-value tubes like 201As or 45s are well worth rebasing. To get the old base off without worrying about the base cement, break the remaining pins and unsolder then. Cut a slit across the bottom of the base with a hacksaw. Insert a screwdriver and twist; this cracks the base off in two halves. Then solder on a new base and recement.

Missing Grid/Plate Caps. The artful restorer keeps a supply of caps from dud tubes. Cap replacement is straightforward if the leadout wire is intact and long enough - just scrape the wire with a razor blade before soldering. If the wire is a bit short, put the new cap on the bench right-side-up and place the tip of a Phillips screwdriver in its center. Tapping the screwdriver will dish-in the cap enough to meet the wire.

If the leadout wire is broken off at the glass, there is still hope. On tubes where the glass seal is long and tapered (e. g., RCA), it is feasible to crush the very end of the seal with pliers to expose a tiny amount of wire. On tubes with a "blob" or rounded seal (e. g. Arcturus), the trick is to use a vibrating engraver (Burgess Vibrograver, etc.) to chip away just a bit of glass, say, 0.020". Then take a few inches of hair-fine copper wire from a piece of zip cord. Loop the center of the wire around the exposed leadout - only a single turn is needed - and solder. This gives two pigtails that will reach up into the new cap.

"Open" Filaments. Oldies like 201As routinely have "open" filaments from corrosion inside the base pins. The best repair is to make a tight hairpin from a short piece of #20 tinned wire. This fills space inside the pin, and gives lots of surface for new solder to grip. Melt the old solder, insert the hairpin, and apply new solder liberally. This also applies to 2.5-volt tubes, which cannot take even small amounts of joint resistance. Resoldering was a standard trick of TV technicians in the days of soldered-base picture tubes.

Resoldering is a slow way to troubleshoot tubes. To determine quickly whether the "open" is real, connect a current-limited high-voltage transformer to the filament pins. If there is an arc visible inside the glass, the tube is hopeless. If not, the current has probably broken down the solder joint and is flowing harmlessly. Resoldering is then justified. A typical high-voltage transformer is the oil-burner type, putting out 10 kV but self-limiting to 23 mA. This current poses no danger to a 250-mA 201A. Neon-sign or bug-zapper transformers would probably work as well.

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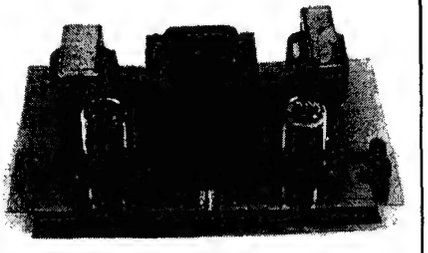
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Leaky Tubes. Old tubes often show inter-electrode leakage. This is generally harmful to circuit operation, but a 201A with, say, a one-megohm leak from grid to filament will work fine in a '20s battery radio.

Many such leaks (other than temporary ones from water getting in the base during washing) result from cathode material evaporating onto insulators inside the tube. These can often be cleared by a brief spritz from the oil-burner transformer - half a second will do. A leaky miniature tube can often be fixed with a vigorous rap on the bench. And there are special cases: a pair of EL34s with leakage from plate to heater (Pin 2 to 3) turned out to have arc tracks burnt into the base. (Someone must have turned the volume up with the speakers disconnected.) Scraping away the burnt material fixed them.

One nice "S"-bulbed UX-280 that had arcing between plate leads inside the base was saved by drilling a hole into the bottom of the base and pushing the wires apart. An old-time tipped BH cold-cathode rectifier that arced-over internally was cured by putting a pair of 1N4007 diodes in its base. This is one of the few cases where silicon diodes are unlikely to stress the rest of the circuit from overvoltage.

Gas. The word among old-time radio operators was that a gassy tube could be saved by applying normal voltages and heating the flashed getter deposit with a small flame. A couple of recent tries on gassy CX-245s failed to confirm this, but it may be worth trying.

Rejuvenation. Reactivating tubes was a well known practice in the '20s but not common later. There are three techniques involved, depending on the type of tube.

For pure-tungsten filaments (in the original 200, 201, and early transmitting types), the goal is simply to evaporate contaminants. Operate the tube at 110% of rated filament voltage for up to half an hour, then retest.

For thoriated-tungsten filaments (in the 10, 22, 71 - not 71A - , 120, 199, 200A, 201A, 216B, 240, and later transmitting types), the trace of thorium on the surface of the filament that provides most of the emission needs to be restored. The starter technique is to operate the filament at 135% of rating for 30 minutes. This makes fresh thorium diffuse to the surface. Test, and repeat once if necessary. If that doesn't succeed, take a deep breath and give the tube 350% of rated voltage for 30 seconds. (This usually wipes out whatever emission there was.) Then let the tube idle at normal voltage for a while - two hours, four hours, overnight - and the emission is usually normal.

For oxide-coated filaments or cathodes, it may be successful to run the tube for an hour before testing. Then go to 120% of rated voltage and monitor the emission for an hour or so. It should slowly increase, peak, and gradually decline. The trick is to go back to normal voltage just after the emission peaks, and let the tube run for at least four hours.

For cathode-type tubes, direct action in nothing-to-lose cases is to apply triple voltage for 30 seconds, let the tube cool, and retest. Tubes with 6.3-volt heaters rarely burn out at 19.6 volts. One or two cycles of this will improve - or impair - a lot of '30s and even "modern" types.

"Eye" Tubes. These are usually dim as-found; being nonessential to the operation of the radio, they were rarely replaced during normal servicing. Despite a couple of hopeful-sounding articles in the collector press, they rarely can be reactivated (this is the result of a test run on 25 "dims"). The villain is not low emission; it appears to be contamination of the willemite (green-glowing) target coating. The contamination is visible on the metal targets of really bad 6E5s and the like; it is easily visible on used 6AL7s, which use a coated mica target and readily show the blackening. Two partial fixes: (1) make sure the 1-meg resistor in the socket is good - an open resistor will dim the display; (2) rewire the plate lead directly to the rectifier output, thus giving it extra voltage. A small increase in voltage gives a disproportionate increase in brightness.

IDENTIFICATION AND DATING MANUFACTURER CODES

Tubes are often marked with private brands. A set-maker (Du Mont, Emerson, Philco, Zenith, etc.) usually equipped its products with tubes made by the tube companies but marked with its own brand then warned the owner to use only its brand for replacements. RMA-EIA codes on the following list may be found on tubes in addition to the private brand. They show the real origin of the product, like "Emerson" tubes made by GE (Code 188), or "Philco" branded items from

National Union (Code 247). The codes do not distinguish between manufacturers and distributors; they appear on, say, imported tubes for which GE was the U.S. distribution agent.

This list can also be used on military codes. The letter codes in parentheses are military identifiers that often give the maker of an unidentified tube - for example, a JAN-CIM-2C39 would be an Eimac product. The services did not put up with third-party manufacture: the code on the tube represents the actual maker.

MANUFACTURER CODES

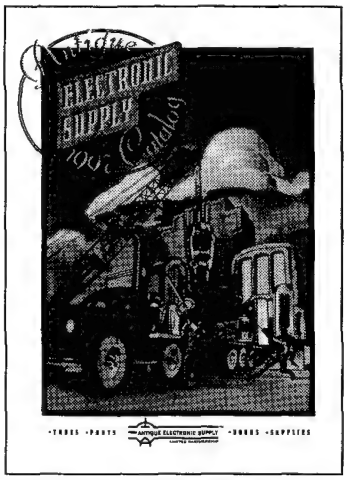
111: Amperex (CEP)
117: Arpin Mfg. Co. (CAPQ)
158: Du Mont (CDU)
162: Eimac (CIM)
170: Electronic Tube Corp./General Atronics (CVG)
177: Farnsworth Tel. & Radio Corp. (CFN)
179: Federal T. & R. Co. (CFT)
188: GE (Ken-Rad) (CG, CKR)
189: General Electronics (CDR)
210: Hytron/CBS-Hytron (CHY)
212: Ind'l & Comm'l Elect. (CIZ)
226: Kuthe Labs (CADK)
231: Machlett Labs (CAGD)
247: National Union/Lansdale Tube Co. (CNU)
260: Philco
274: RCA (CRC)
280: Raytheon (CRP)
301: Sperry Gyroscope Co. (CS)
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312: Sylvania (CHS)
322: Tung-Sol (CTL)
323: United Electronics (CUE)
336: Western Electric (CW)
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354: Lewis Electronics (CYN)
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787: Sonotone Corp. (COZ)
803: Microwave Associates
806: Gordos Corp.
809: Varian Associates
818: Tel-O-Tube Corp.
879: Litton Industries
884: C. R. T. Electronics Corp.
886: Calvideo Tube Corp.
935: Electrons, Inc. (CEL)
940: Bomac Labs. (CBNQ)
964: Huggins Labs
1012: Bendix Red Bank (CJEA)
1101: Rauland (CIY, CBQZ)
1120: General Electrodyn. Corp.
- Arcturus (CAA)
- Cable (Speed) (CRS)
- Canadian Westinghouse (CK)
- Champion (CRS)
- Chatham Electronics (CAHG)
- Daven (CDN)
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Good old J.R. definitely gets our vote for Homebrewer of the Month, December 1948

The first time I ever wound an output transformer was way back when. I was just getting interested in radio, and the XYL was just a YL. I wasn't even in the radio business. I was just an amateur. Money being very scarce those days, I could not afford to buy a decent output transformer for my amplifier. I had a little open-frame 39 cent special and blamed it for the distortion and the short frequency range. I ached to be able to spend ten or twelve bucks for a hi-fi job, but I just didn't have the long green stuff.

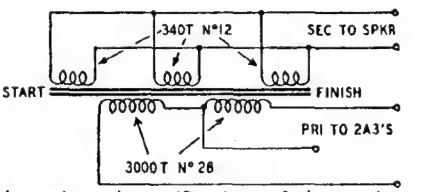
It was the YL who put this particular bug into my head. "Why don't you make your own?" she suggested.

"Me? Wind a transformer myself?" It was absurd. Transformer winding was an esoteric art reserved for the mysterious high-priests of electronics. It was unthinkable,but I thought of it just the same. I heard of a guy who wound transformers, and I made a pilgrimage to see him. He talked, I listened. I bought some beer and was respectful, and he gave me an old burned-out 300-ma power transformer and some insulating paper.

"Here," he said. "This'll make you a honey of an output transformer."

I gulped. "How do I go about it?"

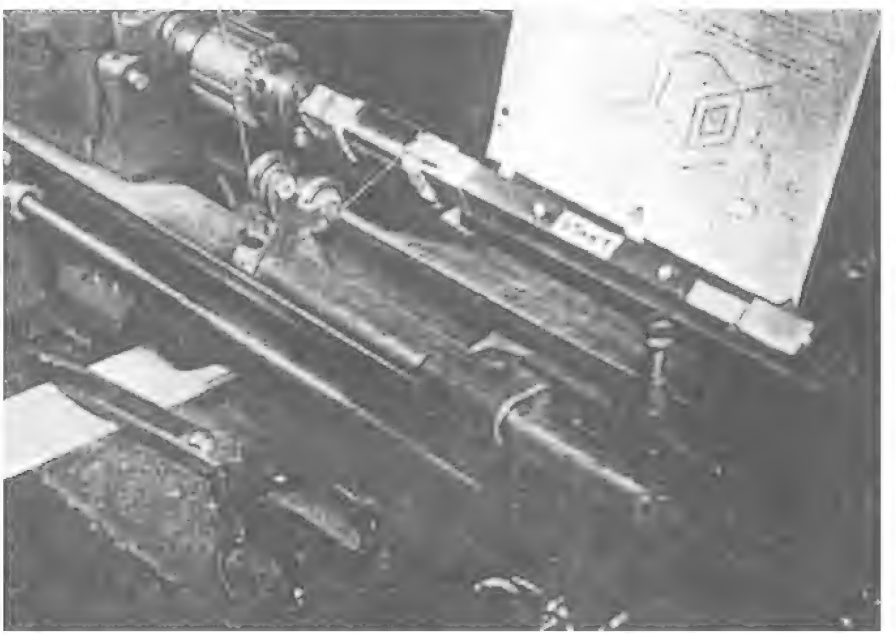
"First un-pot it and knock the laminations apart. Heat them up and then let them cool slowly so they'll get soft. Measure your window carefully and decide how many turns you want of what size wire. You know your impedance ratio, so you know the turns ratio. Get a wire table. Make the primary about half the space available. Put in at least three secondaries and parallel 'em. That's to give good highs. Design it."



Schematic and specifications of the windings.

I gulped and went home with my booty. I melted the tar out and pulled the ugly thing out of the case. I hammered the laminations apart and cooked them in an electric oven over at the technical school. That was to anneal the iron and soften it. It had to cool slowly to do it. I spend a morning easing the temperature up slowly, and then I just shut the oven off and left the laminations in there with the door closed. That was on a Saturday, and I came back on Monday to take them out.

Well, the textbooks gave me most of the dope: the efficiency varies with the amount of copper in the window; bass response is determined by the primary inductance; treble response depends on the leakage inductance (mostly). I knew I wouldn't have to worry about capacitance because it was to be used from tube to speaker and therefore was a low-impedance affair. My impedance ratio was from a pair of 2A3's to a 16-ohm voice coil and amounted to 5000:16, or 312.5. I





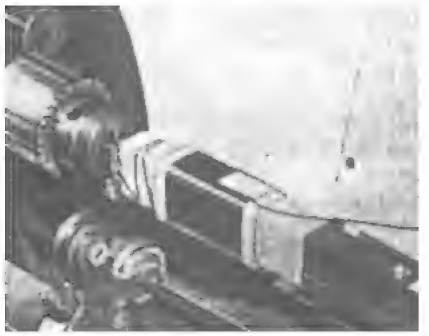
Above, left– First layer wound in place. To start second layer, insert glassine paper under wire so that wire is at least one-eighth inch from paper's edge, and roll it on with the next turn of wire (photo right). Paper secures and stiffens ends of windings.



If an end turn cuts through the glassine, lay a strip of paper under it as shown above



and loop it back, winding other turns over it. Pull the loop up snug after a few turns.



Finishing winding. Place paper loop as shown, wind a few turns over it, pull up loop ends and continue. On last layer pull end turn through and pull loop ends tight. If winding ends midway, use loop as above, wind a few turns over it and slip the end turn through.



knew the turns ratio had to be the square root of that: 17.7 approximately. Plain arithmetic gave that and it meant there had to be 17.7 primary turns for each secondary turn.

I forget now just what the dimensions of my window were, but I remember deciding that 6,000 turns of No. 28 wire would come very close to filling the bill for the primary. The figure of 6000/17.7 meant 340 on my secondary would get the needed impedance ratio.

My friend had told me to make at least three secondaries. That didn't really mean much so I called him on the phone. "Why, its simple," he answered. "To get good high-note response you have to have good coupling. So make three secondaries: one next to the core, another between the two halves of the primary, and the third on the outside. That way you get better coupling between the primary and the secondary. Just tie all three of the secondaries in parallel."

"But I figured 340 turns for my secondary and ..."

"That's fine," he said. "Make three of them and tie 'em together. Just use a smaller-size wire so you can accommodate three 340-turn windings."

"But about this high response business," I said. "The books say it's a matter of leakage inductance and ..."

"That's just a measure of the coupling. With low-impedance stuff the coupling is all that limits your high notes. Forget the capacitance."

I sat down again with my wire tables and figured. 3 X 340 meant 1,020 turns had to go into that space and, what with the thickness of the insulation–hmmmm. No. 12 wire ought to be about right. A trifle light, but No. 11 would be too big. I drew up my winding sketch. (See diagram.)

Now came the big problem: how to do the actual winding. There were several lathes over at the technical school, and the management said I was welcome to use them if I'd clean up after myself. I provided a counter that could be attached to the end of the spindle to keep track of the number of turns. I still had the old cardboard winding form and I stripped all the old wire off it. Then I sawed a piece of wood that fitted nicely into the form and bought my wire.

One more visit to my transformer friend showed me how to tape the ends of each winding layer, and then I started. It went much easier than I had expected. Actually it wasn't hard at all. Tedious, but not at all difficult. It took the better part of the day, what with attaching the counter and setting up a roller for the spool of wire to feed from. I wore heavy gloves and fed it by hand.



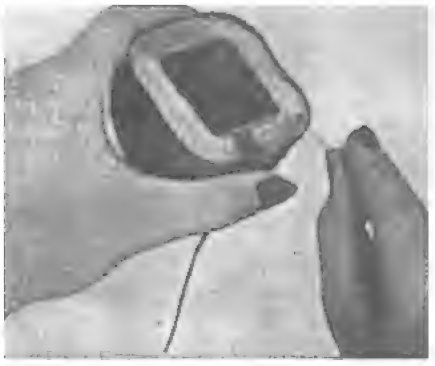
Winding finished with final paper wrapping and a strip of adhesive to hold it secure



Putting insulating fiber between windings evens up the surface and provides insulation



Finished job, showing method of attaching lead wires. These connections are usually



made in the interior, between windings, and are held securely by the windings over them

Cutting the insulation carefully with a pair of shears, I taped it as neatly as possible.

The YL and I had a date that night, and we spent it fitting the laminations into and around the winding and then re-potting the transformer. Her mother still resents the fact that we used a saucepan to heat the tar and pour it into the case. We cleaned it, but I guess we didn't get it as clean as she thought we should have. Tar wouldn't hurt her anyhow. We used to chew it when we were kids.

The transformer was still warm when we bolted it onto the chassis and soldered the leads in. We hadn't checked it for shorts or opens or anything, just hitched it up and tried it out. It worked fine. I swore I could hear lows and highs that hadn't been there before. The old 39 cent open-frame job was given to the YL's kid brother who was building a set at that time.

But that transformer had faults. Several of them. The two halves of the primary weren't balanced properly, and the whole unit was too big and clumsy. My finances improved, and the YL became my XYL, and before long I could buy a big, fancy output transformer and build a new audio amplifier. That old wreck was kicked around the house for a couple of years before it was given, traded really, to a chap I knew. I had never run a test on it at all while I had it.

The new owner did run a test. I was amazed when he gave me the results. He used it in a class-B 6L6 PA amplifier and ran loads of current out one time, and he put an audio oscillator into the circuit as a sort of signal-tracer deal. He found the trouble and then idly twisted the dial on the thing. It went right down to 20 cycles on the bottom and (he said) up to 16 kc on the top.

I frowned when he told me, so he unshipped the big brute from the chassis and made a bench test. The half-power points on the curve were 11 cycles and 23 kc. Those were where the level dropped 3 db. The efficiency was 87% and there was no sign of distortion at 30 watts, which was as much as he had available. All this too, was without feedback, mind you.

It sounded as though it were better than the transformer I had bought. The curve on that was supposed to be 1 db from 20 cycles to 20 kc but it conked out at 12 kc on the top.

I got a new job around then in a laboratory and was put to running bench tests on a whole series of standard transformers. I found an amazing thing: None of the "high-fidelity" transformers tested would meet their published curves. In fact, most of them didn't come near them. There were only two brands among all those I tested whose transformers all came up to their own specifications. Since our work involved Sonar listening gear we had to have the highest possible fidelity in transformers for faithful transmission of submarine sounds. We soon found we could not get enough really good transformers from the busy companies and so we had to wind a lot of our own.

The winding was done much as I had done it. I managed to get those photographs from the U.S. Navy. They show the work done in that laboratory in making up a transformer– and we made a great many of them.

I have since wound up more output transformers for my own outfit and for those of some friends. I use essentially the same techniques as with that first hoary old model. I try to find a big old power transformer that someone has burned out and rip the old windings off it. I anneal the laminations and then design a new winding. This is really very simple and takes just a little figuring. You have to remember these things:

1. Fill up the window with copper. Fill it as full as you can. This governs the efficiency.

2. As a rule of thumb, allot half your space to the primary and half to the secondary. It works fine.

3. Have plenty of turns for the primary to get good low-frequency response. I never use wire larger than No. 30 anymore. Even with 6L6's the transformer still runs plenty cool. For 2A3's you can use even smaller wire if you wish. Lots of turns.

4. Have several secondaries in parallel for your coupling. At least three. Five is even better. Put them here and there and all over and then just tie them together–but watch your polarity.

5. If it's to be for a push-pull amplifier, wind both your primaries at the same time from two spools of wire. That way you can get good balance and keep down the intermodulation distortion. Make them in two sections or three, interleaved with the secondaries, but if you wind both primaries together you'll have a good balance.

6. Lay the turns in closely and don't let any overlaps stay in. Go back and remove them.

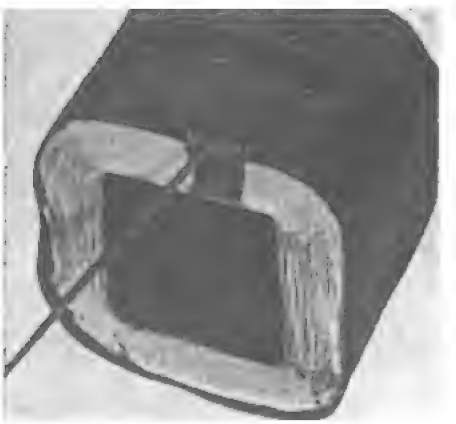
7. Don't use transparent sticky tape if you live near water. Get thin cambric tape and regular thin paper insulation from your supply house.

As to what kind of power transformer is best–that's up to you. The bigger it is, the easier it is to get enough primary turns for good bass response. Just get yourself a wire table and study the turns-per-inch of the different sizes. Don't squeeze it. A thousandth of an inch too little means a slight loss in your efficiency, but a thousandth too much means you can't get the laminations back together and you'll have done your work for nothing. Measure your insulation thickness and plan the whole thing carefully.

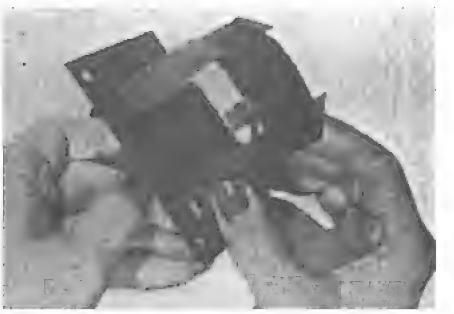
You might be arguing to yourself now, "Well, if it's so easy, why don't the companies make transformers that are as good?" I'll tell you why. The economics are against it. You're worry is about one transformer –your own. They have to think in terms of a thousand or more. Extra wire, extra insulation, and larger cores run up the cost considerably and then they couldn't compete with the other's prices.

You can have any coil-winding firm make you up a special transformer to your own specifications, and it will cost you plenty. Or, if you're a working stiff without much lettuce, you can look around for an old, burned-out 300 mA power transformer and, with a little work, make yourself a really fine output transformer. It's really easy and, what's more, a lot of fun. Try it!

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Adhesive strips make external connections stronger. Whole winding may be taped also.



Last job of all is inserting laminations. This is not hard if all the dimensions are correct



Transformer is now ready for repotting. Don't forget to give it a test run first!

Casual Reactions



by Herb Reichert, Audio Note NYC

The Ressurection of Dead Man Tate

Unbelievable! I'm sitting at this guy's house listening to Buddy Tate play "Darn That Dream" when one of the fellows says, "Hey, stop the music! Let's put my amp in and see how it sounds" – so they put his amp in. Immediately, when the music resumes, I feel like Wegee at a crime scene. I am talking serious necromancy, Folks!

The same record is playing. There is sound coming out of the speakers...but Buddys' a corpse! No tempo, no color, no texture, no movement, no heartbeat, no excitement...Buddys' cold dead folks! His features are clearer than ever and his widow says, "Yep, that's him"— but he sure ain't dancing.

A few minutes into Buddy's wake, the owner of the amp turns to me and asks, "Do you think the soundstage shrunk a little?" My eyes bugged out and I felt like I just took both barrels, right in the chest. "Lord, get me out of audio!"

This kind of missing the musical point entirely is why I had to write this article. Audio today is in the '*looks* like Buddy but it ain't him' era. I doubt that one of my little essays is going to shift the momentum of the present audio/critical encumbrance but, if we do not begin to develop new music-based and user-based criteria for evaluating audio components, if we stick with the mostly irrelevant, non-musical critical devices absorbed from the mainstream audio press, music listening in the home will become as dead as Ron and Nicole.

The current audio critical format is worse than useless. Music unfolds on a different level from computer-generated measurements and holographic tricks. What we need is a simple, user based, musically relevant, and aesthetically valid format for evaluating the quality of audio components. We can't let the imaging weenies, bench testers, and dandruff head ABXers define the culture. That would be like letting the plumbers design the house, wouldn't it?

Harry Pearson actually once said to me, "If a system cannot get the stereo soundstage right, nothing else matters!" Is this true? Am I missing something obvious here? What about dead man Tate? What about when my speakers are not broken in and the music is so lifeless I can't bear to listen? What about all the systems with spectacular imaging that I have heard that forced me to go outside and smoke my pipe for relief? What about whether a system makes me really want to listen? What about whether a system makes it easy for me to pay attention to the music and forget the sound?

This whole soundstage business reminds me of the 16th century Dutch art scene. The emerging merchant bourgeoisie used their new found wealth to acquire the trappings of the aristocracy. They wanted to rise up on the social ladder, using fancy possessions as tools for this purpose. They bought paintings, fine furniture and clothing. Unfortunately, despite their money, they were semi-literate and had not developed a very high level of connoisseurship in the field of great art.

So instead, they commissioned artworks that they could understand and that would be easy to show off to their equally unsophisticated friends. Their peer group, who were also successful business men, understood the value of hard work, long hours and attention to detail. This is how they become wealthy. Makes sense, yes?

Only trouble is, this is not enough for high art. It is enough for high craft though, and this is exactly what they commissioned. Paintings bought by merchant class collectors needed to show 1) Depth and perspective 2) Large vistas 3) Lots of detail and precision workmanship; the results of obviously long hours by the artist and most importantly, easy to recognize and understand subject matter. Sounds like mainstream audio, doesn't it?

Impressive craftsmanship perhaps, but where is the inspiration? Successive generations of avant-garde artists have sneered at these lifeless, boring exercises in excessive detail. Historians call this type of art "academic machines" - overblown objects made only to impress the uninitiated.

Why do we listen to records?

When I walk over to the record stacks to pick out a record, I have one of several motives in mind. Generally, I am in a mood, not one I can define or sometimes even notice, but I am clearly looking for a record to play that will enhance the mood I'm in.

Next time I go, I hate the mood I'm in and want to change it, so I go looking to create a new mood. Sometimes, I say to myself, "I can't remember what the Brahms violin concerto sounds like" or "I can't remember why I don't like it — maybe I should listen again?"

In other words, I pick a record to learn or experience something new. Maybe I am having company and I want to enhance the atmosphere of my home. Sometimes I just listen for a general pick-me-up to generate a little excitement while I work on a painting. I am sure you can think of others but, these are a few of my own familiar reasons for playing recorded music in the home.

I judge the quality of my own hi-fi by how well it succeeds at helping me do these mood and atmosphere things. Clearly, every audio system has varying abilities with regard to generating emotional responses from music, inspiring mood changes and creating atmosphere. Shouldn't home audio's abilities in these areas therefore be *at least part* of the criteria used when assessing "quality"?

One cold grey Tuesday morning, I got into the limo to leave the cemetery after burying my mother, I *needed* to change my mood so I asked the driver to turn on the radio. You won't believe this but, when the radio came on, the first song out of the silence was the Staple Singers doing "Will the Circle be Unbroken". That was the most momentous experience I've had with recorded music. Every time I think of my mother, I am reminded what powerful emotional effects recorded music can have.

My most poignant memories of recorded musical performances were all in very intimate, emotionally charged, social situations and closely tied to the 'who-what-

where' of the emotional stage. The surroundings and memories are probably more important than the equipment used with regards to how we feel about the records we play.

My personal criteria for evaluating any musical experience are: What kind of feelings did it inspire while I was listening and how do I feel remembering it the next day, the next week and the next year? I ask myself, "Did the performance/composition seem exceptional in any way? Does the music stick in my head? Can I bring back the mood or the melody?" The most important question I ask myself is, "Did it fire up my emotions? Did I get all the pleasure and stimulation I was looking for?"

So what do these experiences suggest about evaluating audio components? Is it even possible to sit down with our audio buddies, pull out *Casino Royale*, and attempt to make realistic determinations about system quality? Only if tonight is the night you are all in a James Bond state of mind. Even then you can only ask yourselves, "Did we get that 007 kind of feeling?"

It might be easier if we use really outstanding musical performances by great artists that we enjoy and then only if we listen, suspending our audiophile/critical minds, trying to give ourselves over to the musical flow, and then when the music finishes, we reflect on what we felt. We ask, "Did I get all the fun and excitement this disc has to offer? Could I have had a stronger reaction? Will I have a vivid memory? Does the system seem fundamentally truthful?" When you begin to feel that the disc has offered up most of it's pleasures, then you are getting somewhere audio wise.

Pretend you are a reviewer. You listen to music at home using two different amplifiers and ask yourself, "Which one focused my attention on the performance?" or "Which one gave me the most passionate reaction?" or "Which one picked me up and changed my mood?" or "Which one made me forget about audio sound?" or even more to the point, "Which one just feels right?" Is this kind of critical thinking too abstract? Can anyone legitimately say that the amp that does the above things best is not the best amp?

The reasons we listen to music in the home should provide the foundation for a mutually agreeable set of criteria for evaluating our audio creations. What we intend for our listening sessions to accomplish is exactly the same as what we should hope our playback systems do well. We simply compare audio products based on the degree to which they fulfill our hopes for music in the home. This method is simple and works fine for me.

Unfortunately, not all of our listening intentions will yield the quality evaluation criteria that we need. There are non-musical reasons for selecting a record from the stack, such as: "My friends are coming over and I want some records that will demonstrate how good my system is." Then we have the audiophile classics: "I need to find a Kenneth Wilkenson recording to see if I can hear the second train running under Kingsway Hall" or "I want to see if I can hear the separate voices in the choir".

It's OK to listen to records for reasons like these but keep it in perspective. They are non-musical reasons (I would call them "entertainment reasons"). If we employ them towards evaluating equipment we could end up with non-musical results. Musical reasons are about mood, drama, inspiration and enlightenment, not *detail*. Hi-Fi is about bringing strong feelings and exotic atmospheres into your home.

What about low distortion?

Audio people have been complaining about the lack of correlation between audio measurements and what they hear for as long as I can remember. However, when magazines measure amplifiers they always 1) use sine or square (steady state) waveforms instead of music signal. and 2) use resistors or hypothetical "simulated loads".

Think about this for a second. These measurement techniques *eliminate* the music signal. I thought amps were designed to amplify music signals from preamps (which by the way, are all electrically different)? Bench tests also *eliminate* the loudspeaker and cable. Nobody I know ever listened to records without some sort of transducer connected to the amplifier. And they have *eliminated* the room!

How surprising is it then that correlation between these kind of measurements and what we hear is hard to find. Hell, if you take away the music signal and operate the amplifier in a completely alien environment, what do you expect?

Unfortunately, the test bench is the environment most amps are designed to operate in. Certainly, instruments and bench testing are fine for checking that the amp works in a basic way and they are useful for investigating select electrical phenomena as part of the design/development process and sometimes they can even give us clues about speaker compatibility, but as a final arbiter of quality, I fail to see the value of the usual tests.

In a very recent review, in a most influential audio magazine, by a very influential reviewer, of a highly praised amplifier from one of the biggest and best known audio manufacturers, the reviewer's conclusions made reference to only three things. 1) the "detailed soundstage", 2) the size of the soundstage and 3) the (lack of) "profound bass slam". Oh yes, I forgot, the amplifier had a "respectable set of measurements". What do you think Bo Diddley or Cab Callaway would say if you told them about this jive? I know you won't be surprised to hear this, but I never, ever consider any of these three 'issues' – not at Carnegie hall, not at the Knitting Factory and certainly not while listening to Buckwheat Zydeco on my home hi-fi.

Let's face it, even after forty years of trying, the present format for subjective reviews coupled with standardized bench testing still leaves us clueless as to how to choose or design a better amp or speaker.

What about the obvious?

Before going any further, let's define what we are trying to evaluate. All objects man creates are categorized by their use; clothes to wear, calculators to calculate, cars and buses for transportation, etc.

The present system of audio analyasis starts off wrong by looking at the home hi-fi as a machine designed to recover stored sound information. Then it goes one step further and breaks this machine down into its smallest possible parts; head amp, phono amp, line stage, etc. Next, the critics break the music down into lows, mids, and highs, and so on.

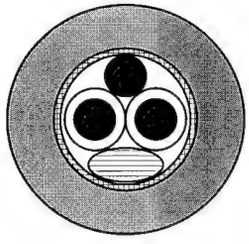
This approach looks good on paper and it is fundamentally-science based, but in practice it results in focusing our complete attention on SONICS! Reviewers listen for sonic details, not performance details. Today, we ask a hi-fi to sound a certain, predetermined way. Instead we should ask if artistic expression is rendered more or less tangible.

We should not assume that if we have flat in-room response from 20-20,000 Hz coupled with a clean 20K square wave and low measured distortion that *any*, let alone *all*, of the musical expression will still be

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Joe Roberts, SOUND PRACTICES, ISSUE 6

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there. There is no evidence whatsoever to support this notion.

We must begin to look at the *whole hi-fi* as a tool that we use to discover and enjoy music. Like all other tools, we can evaluate it based on its usefulness and dependability; how convincingly does it help us understand and enjoy music from discs?

The best systems retain enough of the original music's proportions that their presentation seems "just right". As with cars, houses, or shoes, *anyone* can tell the basically good from the basically bad *easily* by how it feels when they are using it.

The audio establishment maintains that if a system is "neutral, transparent, dynamic and focused, with bass slam, if it has a wide and deep soundstage and excellent imaging" it will automatically do the emotional stuff. Not true! Go to almost any audio salon and listen and you will experience this lie.

Clearly, mainstream audio has been of two minds about these issues of purpose since the advent of hi-fi in the early 1950s. Mono-era combovers listened to trains, pipe organs, and bombastic big bands. Early stereo shifted the scene clearly towards the 3-D sonic spectacular and when the big solid-state amps arrived, the 'how-does-it-feel' concept had to be canned, in order to advance the cause. This, by the way, is when the wives and kids stopped listening to "Dad's" hi-fi.

By the late '70s, Harry Pearson was defining the soundstage and publishing his *Super Disc List*. The era of the 'Stereo Spectacular' had fully arrived. Foils and wires and cylinders and lacquers and mono vinyl officially became unable to tell us anything really important about the musical performances they stored.

The Absolute Sound provided the hip agenda for critical thought in the late 70s and early 80s. HP's main scheme was a critical program based on the concept of *recording as photograph* that only applied to recorded music in stereo, What started out as an intriguing sideline fetish of far-gone audiophiles was elevated to the last word on reproduction. Soon, the audiophile weenie larvae were hatching everywhere.

The imaging and soundstaging act really caught on with the enthusiast public. It was a simple language but it sounded knowing, perceptive, and sophisticated. I'll admit that it sure was fun to have a common ground to hang out with fellow audiophiles, act like a bunch of reviewers, and talk about our experiences with "high end" equipment. A lot of folks out there still like doing it the same exact way, using the same old lingo, and listening to the same damn awful "audiophile" recordings.

Once the concept of imaging took hold it pretty much defined the agenda for "serious" audio journalism ever after. For a while, the high end critical perspective did more good than harm because it did foster a community of serious, thoughtful folks in the beginning. Eventually, the whole scheme became too literal and inflexible, too focused on the details, and too mechanical and routine.

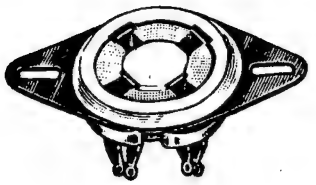
Look at what happened to the used record stores. Previously, the value of used records was determined primarily by the quality of the performance and the scarcity of the disc. HP's *Super Disc List* and *Mark's Barks* changed all that. Sound and soundstage considerations rather than performance quality, became the driver of record prices.

A new era of record collecting had begun. People pay high prices for records whose *only* recommendation is good stereo sonics. Mono discs of the same performances have no value. The quality of musical performances almost doesn't matter anymore.

A similar movement occurred in the equipment market during the High-End years. Side issues took over the entire stage. Sure today's systems image like crazy, but in 20 years "High-End" made no pronounced advances in the areas of presence, wholeness, completeness, color, texture, tempo, scale, weight, body, drama, contrast or sheer listenability. One could even argue that the hi-fi gear of 1976 or 1956 was superior in most of these dimensions. These are all aspects of reproduction that profoundly affect how reproduced music *feels* while we listen and isn't that the most important thing?

That is why I am calling for a new set of audio evaluation criteria based not on technical stereo sonics but on a system's abilities to evoke, persuade and create strong musical memories. How well an audio system serves these purposes is far more important than any purely sonic consideration should be.

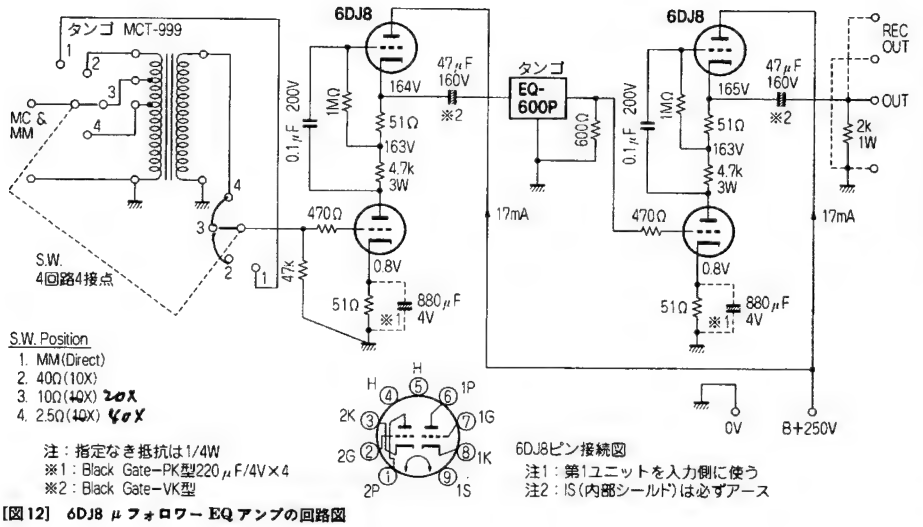




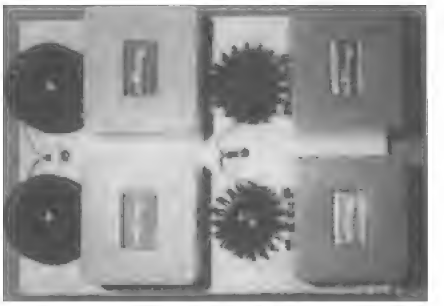
Tube Circuit News

from around the world

LCR Phono Preamp by Nobu Shishido
from MJ Audio Technology 1996/11 (Japan)



[図12] 6DJ8 μフォロワーEQアンプの回路図



[写真1] 実験のため仮組みしたEQアンプの配置



[写真2] 仮組みEQアンプ部の配線

"Simplest is best" phono amplifier using 600 Ω Tango EQ-600P RIAA network. Although the EQ-600P is an expensive part at $300 ea., usually modest Shishido says the preamp sounds great and is worth the parts investment. The LCR EQ preamp was designed to be used with a high-quality passive atttenuator between it and a power amplifier.

Alesa Vaic AUDIO NOTE

Exclusive Worldwide Cooperation

An agreement has been made between Audio Note, UK Ltd. and Mr. Alesa Vaic (formerly of Vaic Valve) to set up a manufacturing and distribution arrangement, whereby Mr. Vaic in conjunction with the Audio Note design team, will develop, design, and manufacture a range of AV high-gain small signal directly heated triodes, together with a range of AV Super Linear™ driver and power triodes, financed by Audio Note and distributed under the Audio Note brand name.

Alesa Vaic is no longer associated in any way with KR Enterprises (formerly known as Vaic Valve AG). We are enthusiastic that our cooperative agreement will provide a fertile environment for Mr. Vaic's patented innovations in valve technology and ensure reliable manufacture and distribution of Mr. Vaic's new generation designs.

Production will start on a highly linear version of the 300B, dubbed the AV300B S. It will be available from late December 1996 in limited quantities of numbered units, backed by Audio Note's worldwide distribution network and carrying a 12 month or 2,000 hour absolutely undisputed warranty. At a worldwide retail price of $425 each, the AV300B SL will substantially improve on the sound of any equivalent types, including the WE 300B.

Within 6 months of the launch of the AV300B SL, we intend to introduce a higher power triode with a dissipation of 120 W (35-40 W Class A) dubbed the Audio Note AV62B SL at an estimated cost of $750 each.

The Audio Note AV32B SL and AV52B SL

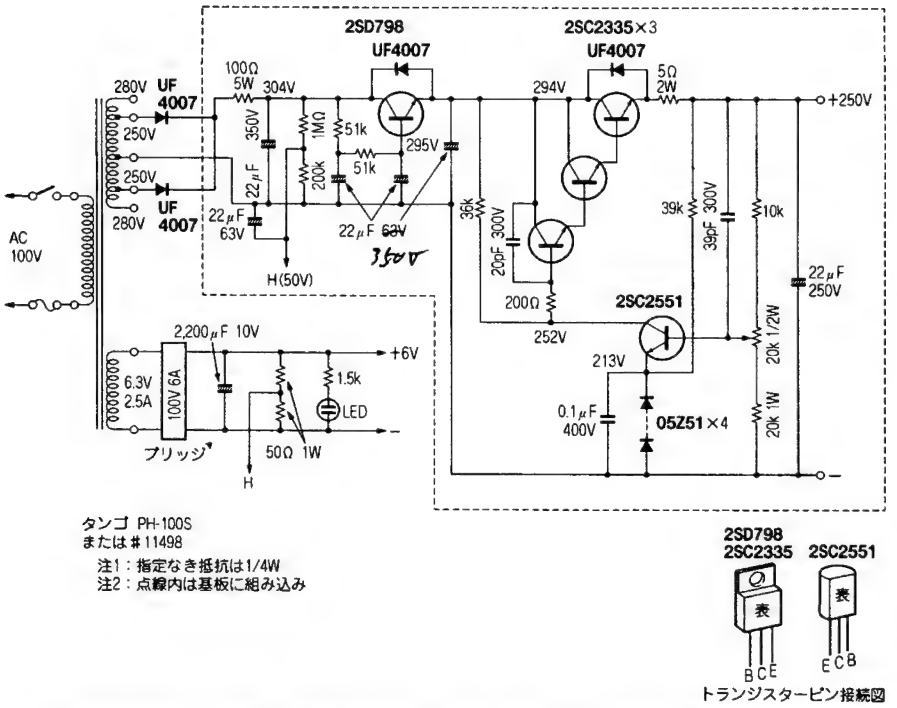
Audio Note and Alesa Vaic Vacuum Technology have introduced substantial improvements in cathode chemistry for enhanced reliability and performance over previous efforts. The two replacement types The Audio Note AV32VB SL at $550 ea. and The Audio Note AV52B SL at $650 will be launched sometime in 1997.

Suitable Audio Note amplifiers and circuits are being developed to derive the best possible results from the unique properties of these triodes and support the advancement of the art and debate on single-ended audio amplifiers.

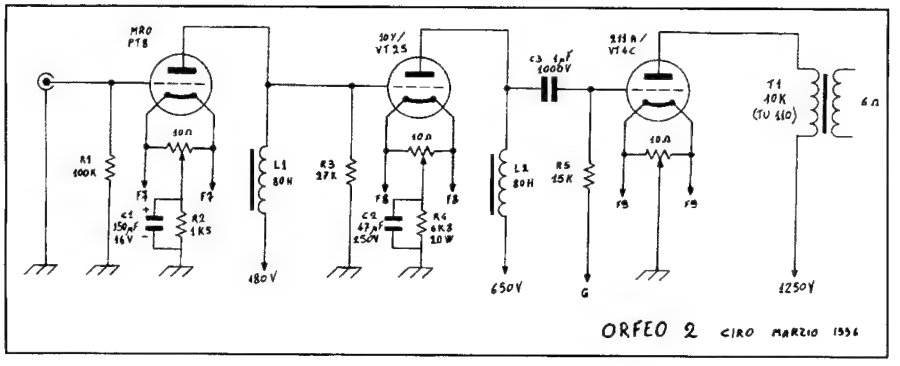
Outside the Audio Note distribution network, Audio Note UK Ltd will license the use of the AN triodes to a strictly limited number of amplifier manufacturers to ensure that the quality of the end products are consistent with the quality of the amplifying devices. Please fax applications for registration of interest to Mr. Paul Masson +44 1273 731498

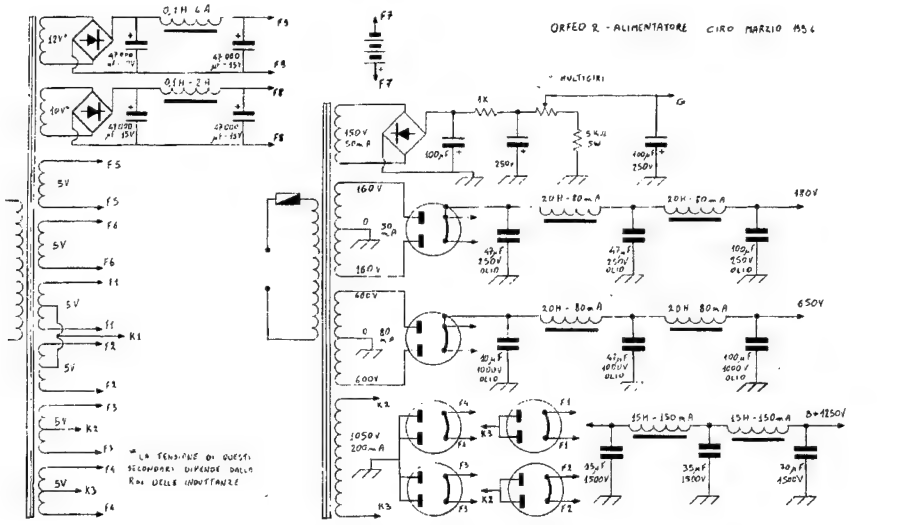
Peter Qvortrup
Audio Note UK Ltd

AVVT Inc Alesa VAIC
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Regulated Power Supply for Shishido's LCR EQ phono amplifier





Orfeo II Power Supply

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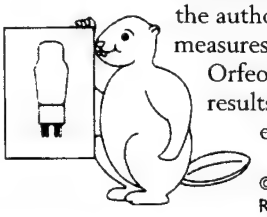
Foreign countries dealer & distributor inquiries welcome

Orfeo Update by Ciro Marzio from Costruire Hi-fi #23(Italy)

Two choke loaded stages, 8 power supply chokes, six oil caps, a couple of power transformers, eight filament supplies plus a battery filament supply for the PT8 input tube makes for a hefty amplifier indeed!

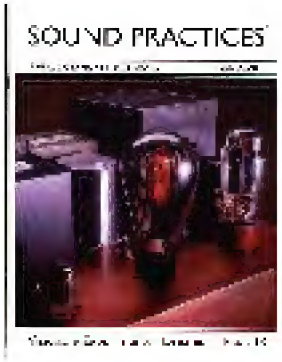
All in all, the Orfeo II appears to be even heavier and more expensive to build than the original *Orfeo 211 SE* amplifer described by Marzio and Jelasi in SP #6, even though that may be hard to imagine.

Unfortunately, no picture of the Orfeo II accompanied the CHF article, but surely each channel must be at least the size of a small dining table. An amplifier with three choke or transformer loaded stages and individual tube rectfied, choke-smoothed, oil-capped power supplies worthy of the job has to be a real monster. According to the author, the extra measures taken in the Orfeo II yield sonic results that are simply extraordinary.



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Issue Thirteen



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Casual Reactions Herb Reichert

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Unconventional OTL Amp Fabio Camorani

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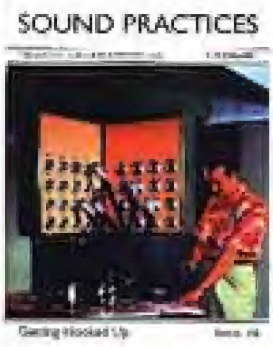
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Secrets of the Phono Stage Allen Wright

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Hifi a la Renoir: 10 SE Line Stage Dominique Mafrand

MonoPhono Diego Nardi

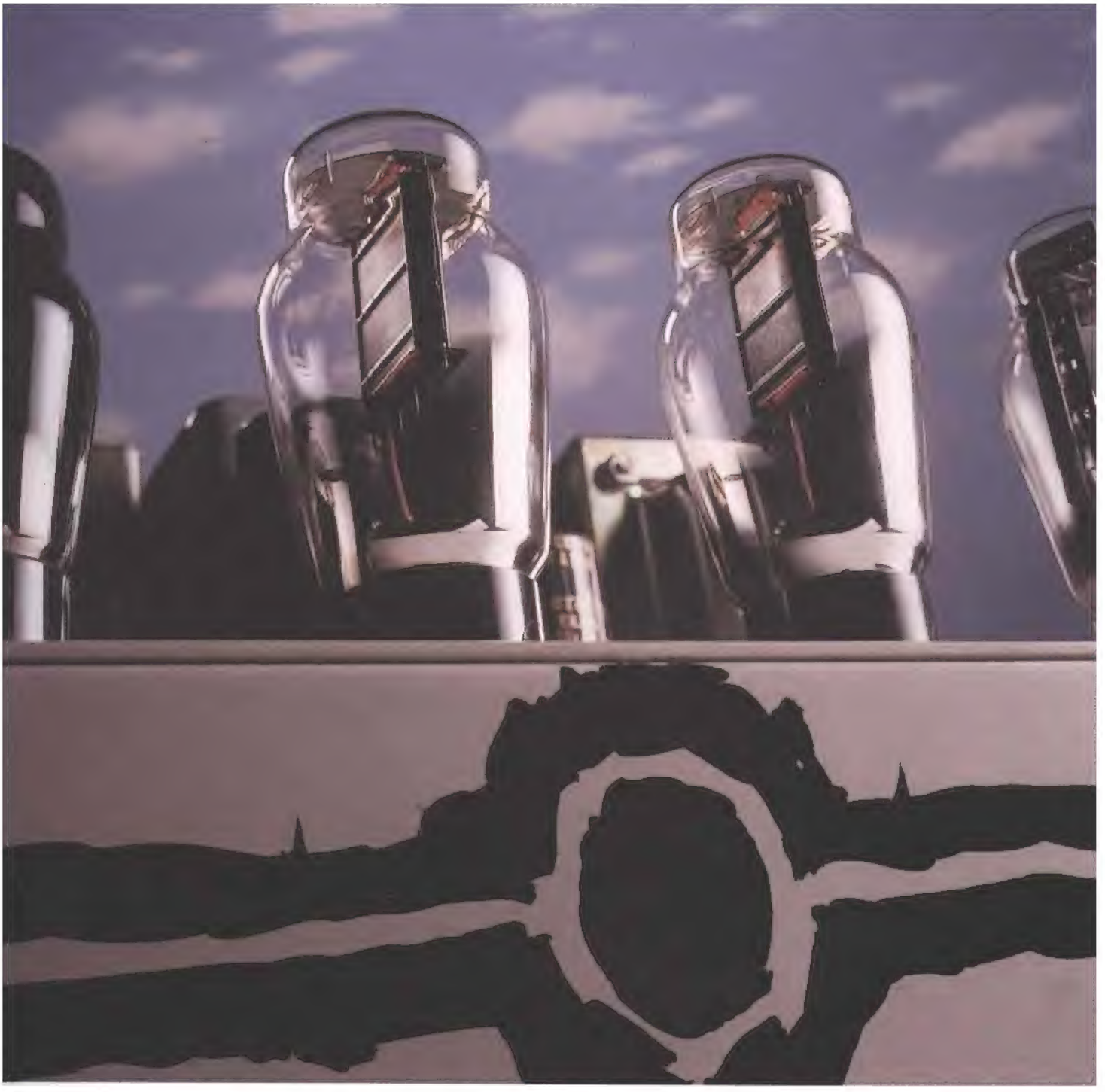
MV45 Convertible Steve Berger

High Efficiency Triode Amp Melvin Sprinkle

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SOUND PRACTICES

THE AUDIO EXPERIMENTERS JOURNAL FIVE DOLLARS



Visionary Experimenter Dreams Issue 13

Direct Heating with the SAKUMA SYSTEM



by Susumu Sakuma

My old friends, VT25/801A push-pull preamplifier and PX4/PX4 SE power amplifier began singing "Manha de Carnaval" from *Black Orpheus* with a Lowther PM6 unit.

Under the misty spring sky, in my dimly-lit restaurant *Concorde*, I lean against the brick wall. A cooling breeze through the window brushes my eyes.

I see a scene over the breeze— that summer day when I made the amplifier, the 845/845 push-pull monaural power amplifier...

My two friends work in the lane outside the *Concorde's* entrance punching holes in an aluminum chassis. They have to finish the work before the noon hour, because it is very warm in the summer afternoon and the entrance must be clear for guests to have lunch.

A wood plank on two beer crates is my workbench for chassis construction. One guy drilled and another filed the holes smooth, wet with sweat. I bring cold Japanese tea to them.

A few humble tools and the workshop under the blue sky. Simple circuit design and old style devices, transformers and triodes. I have made my many amplifiers with these elements.

Can the engineers in the clean room with air conditioner and computers make amplifiers which can tell us the passion of the players and convey the strenuous efforts of the composers?

Design Concept

The schematics show you my concept in power amplifier design. I use the same tube for driver and output.

I made PX4/PX4 SE power amplifier, RCA50/RCA50 SE power amplifier. Their tones are clear and powerful. Through listening, I discovered that the driver's tone contributes the greater part of the amplifier's voice. An excellent power tube demands a similar level of quality from its driver. Few driver tubes can sing along in beautiful harmony with a good power tube.

I also made 300B push-pull/300B push-pull power amplifier. Before this, I didn't have the impression that the 300B tone was very elegant. But the special tone of the 300B push-pull driver/300B push-pull output power amplifier taught me the true *Western Electric* sound.



About "Unusual"

Certain "unusual" aspects in my schematics present mysterious contradictions and may raise doubts in some minds. You may say this is not a *volume control* but rather a *tone control* because it interacts with my *intentionally mismatched* input transformer.

But who has such doubts among those who have attended my audio concerts in Japan and Europe?

I understand that your doubts are grounded in accepted theory. I know this because I had to work through the barriers of convention myself. Now I assert that theory in electronics reference books took my favorite music from my life for a long time.

I think an amplifier builder should consult with himself and his amplifier before asking the reference books and authorities.

It is only after much cut-and-try that I find my best matching point for audio. The tube manual is like a telephone book. It gives perfect numbers. It is useful to make it possible to speak with a girl— but we cannot see her beautiful face from the mere telephone number.

To get the best sound from a tube, even if the proper match is 5K, we will try 7K. And we try these "mismatched" values with input transformers and other parts.

When you finally find the best operating point for the tube, you get the girl's address.

A few days ago, my friend, an experienced craftsman, painted the chassis in dark brown. I begged Kuniko, my wife, to cover the chassis with a soft cloth so the fresh paint won't be damaged.

I want to mount the parts soon but this big chassis, 65cm wide and 35cm deep, absorbs all the power from my body and heart.

For five days I have worked and listened to music, watching the chassis in repose on a round table. I keep the chassis like a wine. This is the most important technique of my craft.

There are two key matters in building amplifiers and audio systems.

One is to recognize the value of family and one's many friendships.

The other is inducing cooperation between human and machine.

After many hours of listening to music together, the chassis seems to recognize "who I am." It turns from mere sheet metal into the chassis for my amplifiers. I can then imagine the perfectly built amplifier. This moment is the end of my design, my planning, and yesterday's me. Now I must play my self ad lib.

It is easy to build from a reference book or from a magazine. But we cannot make the amplifier better that way. When I make an amplifier, I listen and listen to music so as to find 'what I need' in my imagination. Once I find that, the amplifier design and building are very easy. I take a screwdriver and mount all transformers and other parts in about one hour.

Parts

All transformers are made by Tamura of Japan. The custom-made STU-001 is expected to become a standard Tamura item. The other custom transformers were made to my order and are not likely to become catalog items.

This amorphous core interstage transformer (DC150mA) was a collaborative effort based on two years of listening tests. Tamura's good quality ITs enable me to use the same type of tube for driver and output.

Although Tamura ceased production of the 5k:20k 150 mA driver transformer because of high manufacturing cost, you can substitute a STU-5K (DC80mA), which is sold only by Sun Audio, the Tamura distributor in Japan.

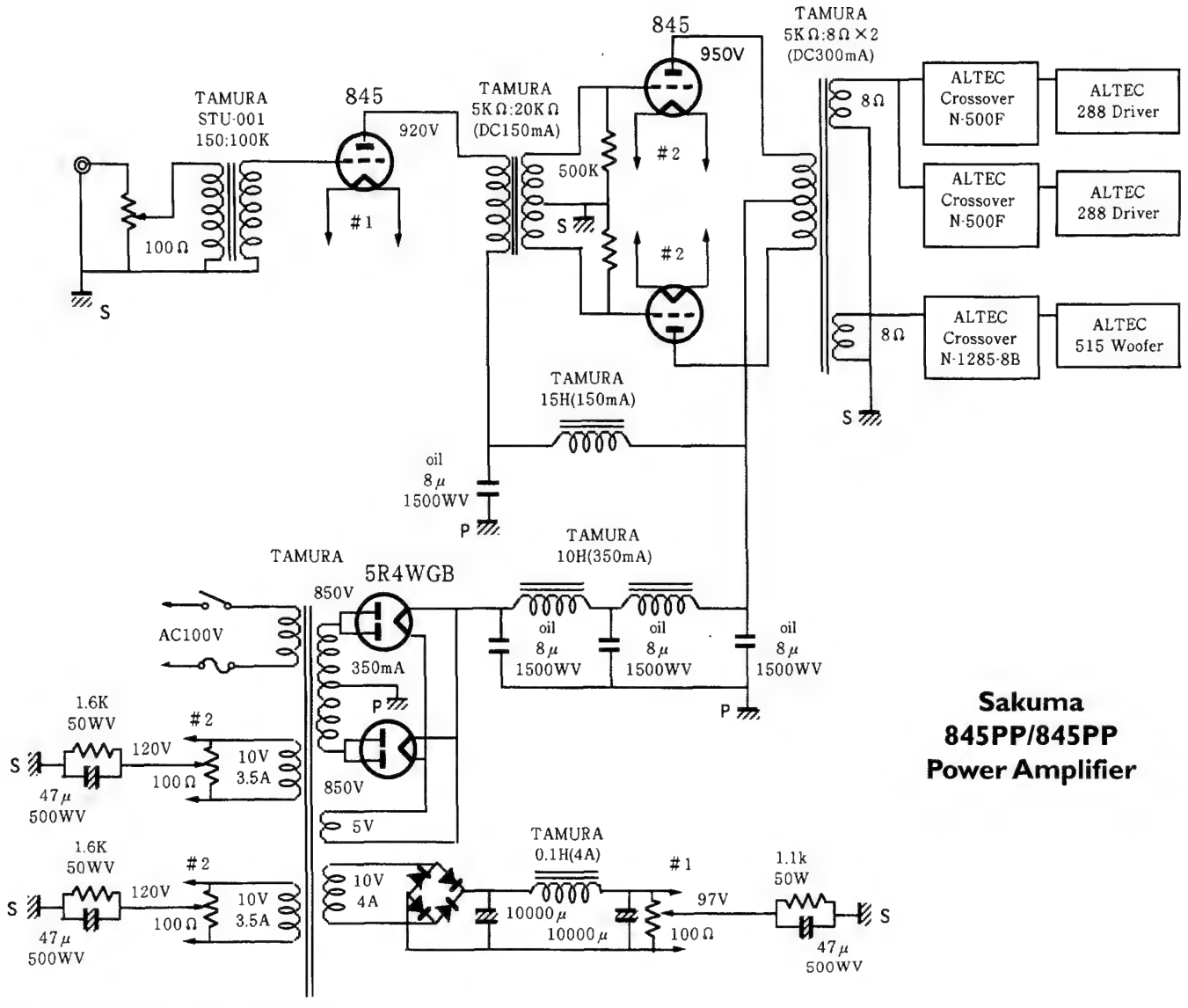
Let me explain about amorphous cores. There are three kinds of audio transformers: Si-Fe type, Ni-Fe (permalloy), and amorphous. Amorphous is composed of Fe-Ni or Fe-Co, but it is not an alloy. It has no regular crystals of metal. Physically, it is like glass and quite brittle but Tamura got around this with special manufacturing technology. The other challenge that Tamura had to overcome was that amorphous material saturates even more easily than permalloy or pure nickel, so here again special techinques were employed.

I find the amorphous core to be excellent throughout the frequency range, however, its extremely clear sound requires color and power elsewhere in the amplifier. Some builders who tried amorphous cores say the low frequencies are weak. My answer is simple— their grief comes not from the amorphous core but the poor quality of the parts used elsewhere in the amplifier.

The output transformer's core is also made of amorphous strip material. It has two secondary windings for separate outputs for drivers and woofer, to bring out the powerful and clear sound of the Altec speaker system.

Capacitors are Nikkemi or Nichicon make. Resistors are cheap metal oxide-type.

I always use wire meeting Japanese AC code for the speaker cable and general-purpose hookup wire inside the amplifier. I use Belden wire for power supply, filament, and signal line.



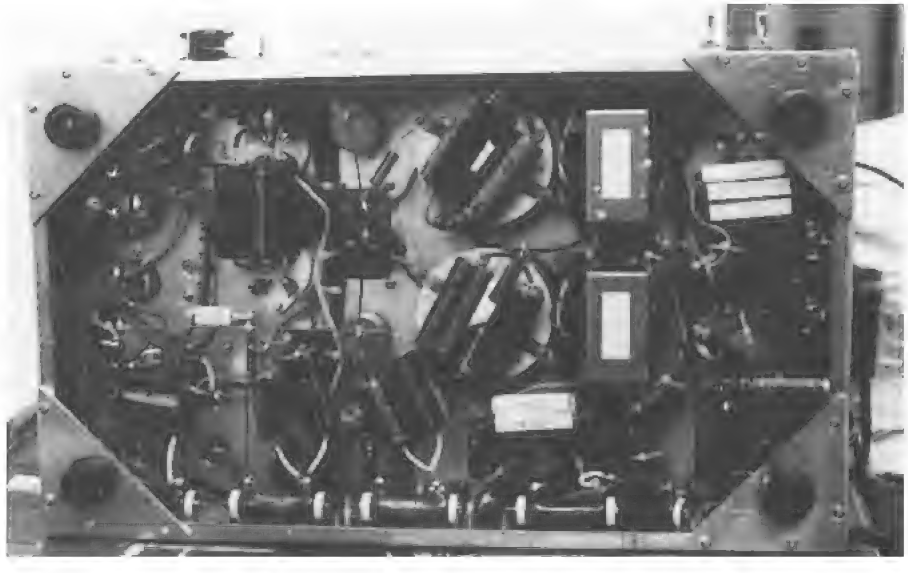
Sakuma
845PP/845PP
Power Amplifier

Wiring: The Two-Point Earth Method

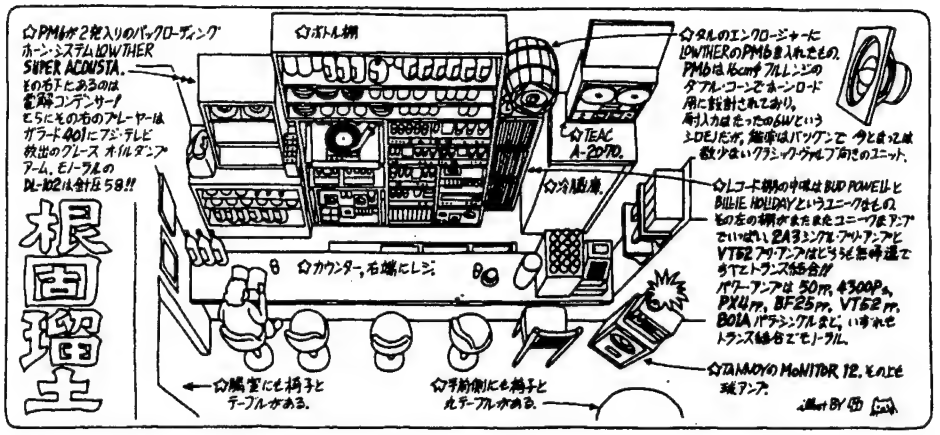
I use the two-Point Earth Method to reduce AC hum. With this method, I don't need DC heating of the final tube's filament.

Please observe the schematics again. The earth symbol with "S" refers to "earth of Signal." "P" is as "earth of Power supply."

I use heavy bare copper wire with a diameter of more than 3mm for the main earth buss. The signal earth buss is connected to the input terminal and the other end is connected to speaker output terminal. This line connects with the chassis at one point near the input terminal.



Underside of a Sakuma amplifier illustrating ground buss technique. Wiring of signal earth buss is visible to left of amplifier.



Bird's -eye view of one corner of the Restaurant Concorde sound system The Lowther PM-6 is mounted in a wooden beer barrel hung from chains

The power supply earth line connects with the chassis at one point near the power transformer.

All ground points are connected to the signal earth line. However, don't connect the end of earth line with the chassis before finishing all wiring and soldering. When the wiring is finished, touch the probes of the tester to the chassis and the earth line. If the tester shows no current, then you can connect earth line to chassis.

Unfortunately, if the tester indicates current, you must search and correct a short somewhere in the circuit.

Many amplifier builders bundle and tie the wires together. A lot of noise and AC hum results from this practice. Although the inside of my amplifiers are not beautiful like the rich catalog pictures of commercial products, my amplifiers don't need DC current for the output tubes!

The picture of the underside of one of my amps above shows you the wiring technique. Although this is not the 845 amplifier discussed in this article, it will serve to illustrate my method.

Throughout the time I am wiring it, the amplifier rests on the round table. This table is the best spot in the *Concorde* restaurant to enjoy both food and sound.

Customers sit at this table. They eat and drink with little notice of this monster amplifier laid before their noses.

I don't mind, because their frank criticisms have made my sound. It is easy to earn five stars on my food but it is very hard to get even one star for audio!

Sound report

My system is monaural. I use a Garrard 401 motor and Denon DL102 monaural cartridge mounted on an oil-damped tonearm for phono reproduction.The DL-102 cartridge is designed to output mono signal from a stereo LP, so it does not endanger modern LPs. It is used at AM broadcast stations for this purpose.

To obtain a mono signal from CD and DAT, I made up a converter using some transformers, capacitors, and resistors.

I chose my VT25/801A push-pull preamplifier to drive the new 845 amplifier. The 801A has a uniquely beautiful character in the high frequencies, which I think would combine well with the 845's rich and powerful midrange.

First I listened to Duke Jordan trio playing "A Night in Tunisia" and "Summer Time." I lost my words...

The sound appeared suddenly as if an apparition and the audio system vanished. This amplifier destroys a wall between me and the jazz players. In Art Blakey's solo drumming in "A Night in Tunisia" and in Jordan's piano in "Summer Time," I see their philosophy of life.

The amorphous core transformer has powerful and speedy bass. The 845 is very powerful. But the most important goal is not 'power,' but 'energy' and 'frame of tone.' The only way to get Energy and Frame is to mount many transformers, although I can't tell you a scientific reason for this.

845 driving amorphous core transformers can shade the sound of music. I see the human story in the bright and shadow of 845's tone.

To use an example from the painterly arts, Rembrandt's expression through light and shadow is marvellous. Most figures on his canvas reside in darkness. Lighted figures he draws only partially. Our eyes are initially drawn to the lighted part, but to recognize Rembrandt's theme, the darkest areas need to be searched. Darkness is silence; this darkness includes many subtleties to which we must listen. Darkness makes us search our imagination.

Amplifier builders seem to think that clear and "accurate" tone can express the essence of music. I need non-analytical tone in reproduced sound. I aspire to Rembrandt's interplay of light and shadow, to evoke memories both happy and sad.

My audio life is to make emotional shadows from sounds. Hints are found in the many transformers. I draw the contrasts





with transformers and tubes. I hope the amplifiers will be my portrait.

Ending

I come back to myself when the Lowther PM6 unit tells me the end of LP.

I go to the player and lift the arm.

As I return the LP to the shelf, I notice a book resting there. That small volume, "Opium" by Jean Cocteau, has greatly influenced me and my audio life.

I read again.

"When I record my poets, I dislike the notion of taking a picture of a voice. I notice there is a problem. If this problem can be solved, the recordings will turn from being the camera for our ears to become a new tool for our hearing. Then this new tool promises us new surprise future.

The machine's hard voice is not same as my voice and is the result of the co-operation with human and machine.

Don't admire machine. Don't regard machine as tool which we can control easily. And create with machine."

I close the book

It is evening by this time

Midnight

Heavy rain

It seems to destroy
my poor restaurant

I stare at the new 845 pre-amplifier which I am building

Solder is burning my fingers

The lines twist about

Something holds its breath
behind me

My ears are full
with the sound of beating rain

Blue eye of tube looks at me

I look at it back

All walls bear down on me

I lost my being



tubes
sockets
transformers
chokes

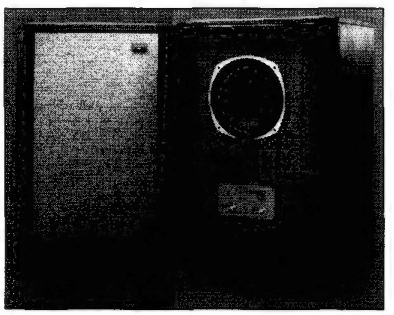
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Nuance 845

by Adnan Arduman
Istanbul, Turkey

Deciding to go for it...

"What would you like to achieve in life?" was an out of the blue question that my wife asked me two years ago. How should a Turkish citizen, living in Istanbul, 43 years old (41 at that time), mechanical engineer, representing and distributing Carrier Air Conditioning equipment in Turkey for many years, an Audiophile tube and Music lover and the president (this year) of Istanbul Hi Fi Club reply to this question? Although not very uncommon, the question struck me as if I was hearing it for the first time—maybe I was hearing it for the first time!

"I want to design and build my own tube amplifier," was my reply, "but unfortunately I have to wait my retirement." She suggested that I should consider starting it at that very moment (she is a therapist!!). Her following arguments were convincing enough and the idea so attractive, I agreed.

First I contacted my electronic guru friend (who builds his own marble speakers) and asked him if he would volunteer to teach me just enough electronics to achieve my project. He gladly accepted, gave me several books and suggested I subscribe to both Glass Audio and Sound Practices [*...but not necessarily in that order —ed.*] and buy all past issues, which I did. After much reading, lessons from my friend, my realization of the analogy between tube curves/load lines and the pump curves/system curves I'm used to working with in my job, the inner workings of amplifiers eventually began to make sense to me.

Thanks to the great influence of SP magazine I've decided to build a single ended amp (the concept of SE or PP was totally new to me). For a beginner SE amps were easier to understand and to conceive, apparently had a magical mid-range, were unheard of here in Turkey, in other words it was a "Mystery Cafe". My intuition (which played a major role throughout the project) also said: SE.

The whole point of the project was to improve on the sound of my existing push-pull ARC Classic 60 amp; here again my intuition said that only a "cost-no-object" SE amp would be able to achieve this goal. It had to be as purist as possible (no parallel tubes) and capable of driving a relatively wide range of speakers.

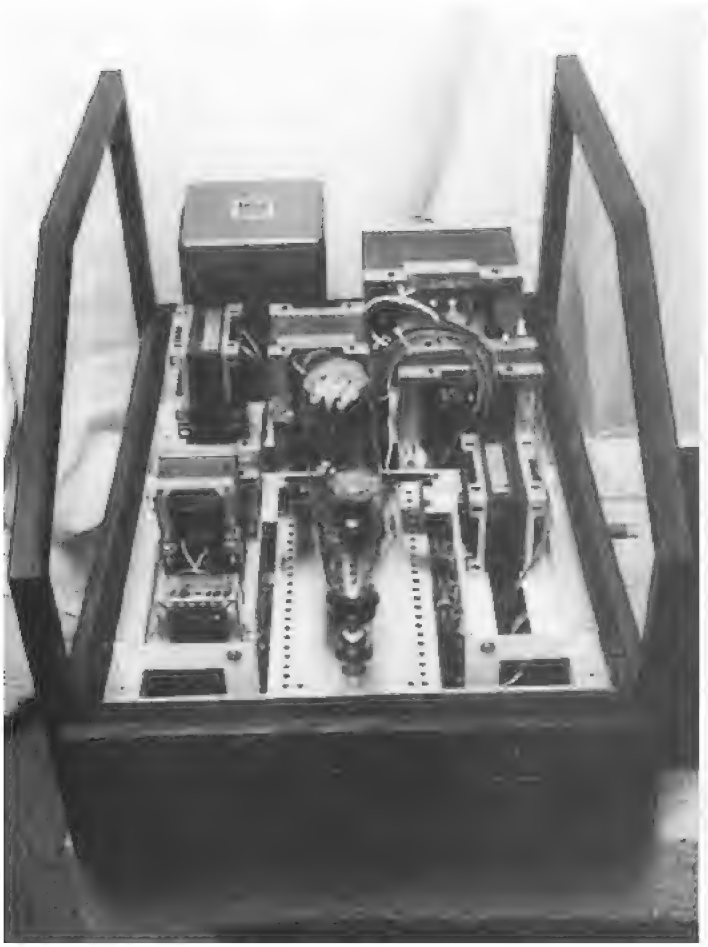
I chose to build a single 845 tube, driven by 300B with a SRPP configured 6072A at the front end. Separate power supply circuits for each tube and mono design would be adopted. Gordon Rankin's article ("A Single '807' Amplifier", issue #2) was a great help for starting my calculation and design.

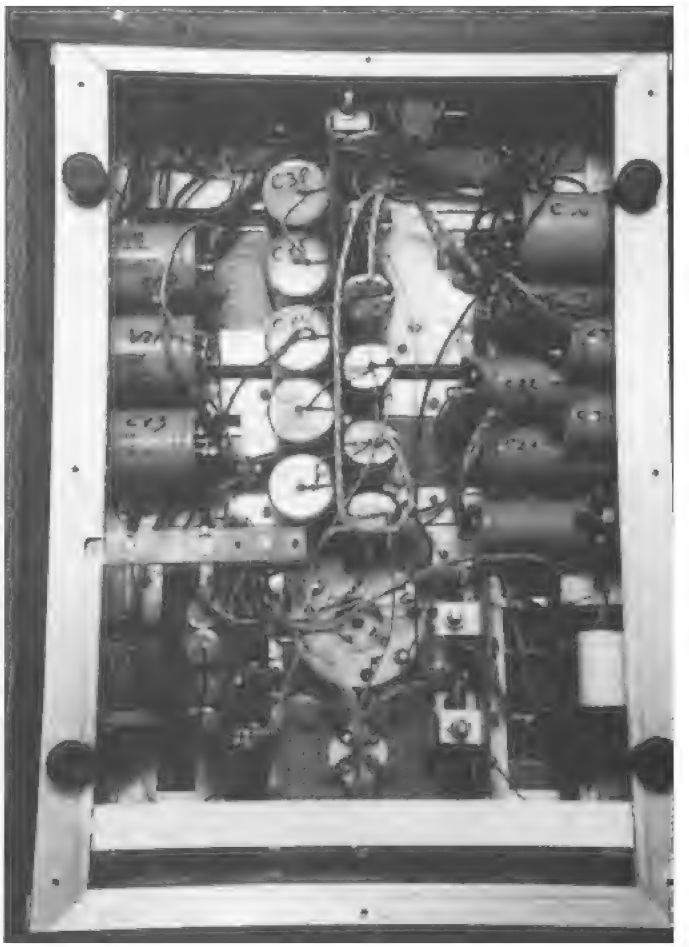
After finishing my preliminary calculations and circuit schematic, I contacted Allen Wright (author of *The Tube Preamp Cookbook*) for consultancy. He suggested that I use "choke input" filters instead of the originally drawn capacitor input ones. "As you aim a cost-no-object amp you should have the best filtration, and choke inputs will give you a much better result if you have space and money to spend. Thus, you may as well use solid state diodes as their switching noise will be filtered by the chokes. It is also the solution adopted by Cello," was his argument to defend the choke input.

He suggested to split the first choke to two and place one to positive and one to negative leg after the bridge in order to filter the whole of the mains trash. Verifying what he had mentioned with the *Radiotron Designers Handbook* and cross checking it with my guru friend, I applied his suggestion to the point and used three chokes per tube (in total 9 chokes per side!).

The same purist philosophy and intuition was in use when it came to selecting and







Top and bottom views showing constructional details of Adnan's Nuance 845 single amplifier

ordering the components: I used TANGO X-10S OPT (best of TANGO for 845 tubes), Gold Aero tubes, Caddock, Vishay, Holco resistors, Hovland Caps on the signal path and MIT bypassed SOLEN's elsewhere, Kimber AG cable on all signal paths, SOWTER mains transformers and inductors.

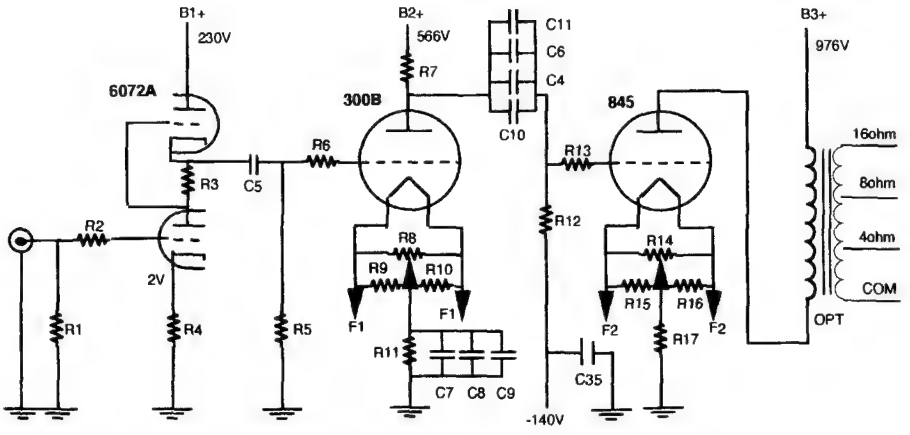
Since I had very good results picking up more detail and extension on the top end) when I tried bypassing the 250 uF electrolytic input capacitor of my Quad 63 speakers, I decided to bypass all capacitors As a unique touch, an LCD display hour meter is included. This would be useful to indicate the burn-in times and give me an exact statistical idea about tube life.

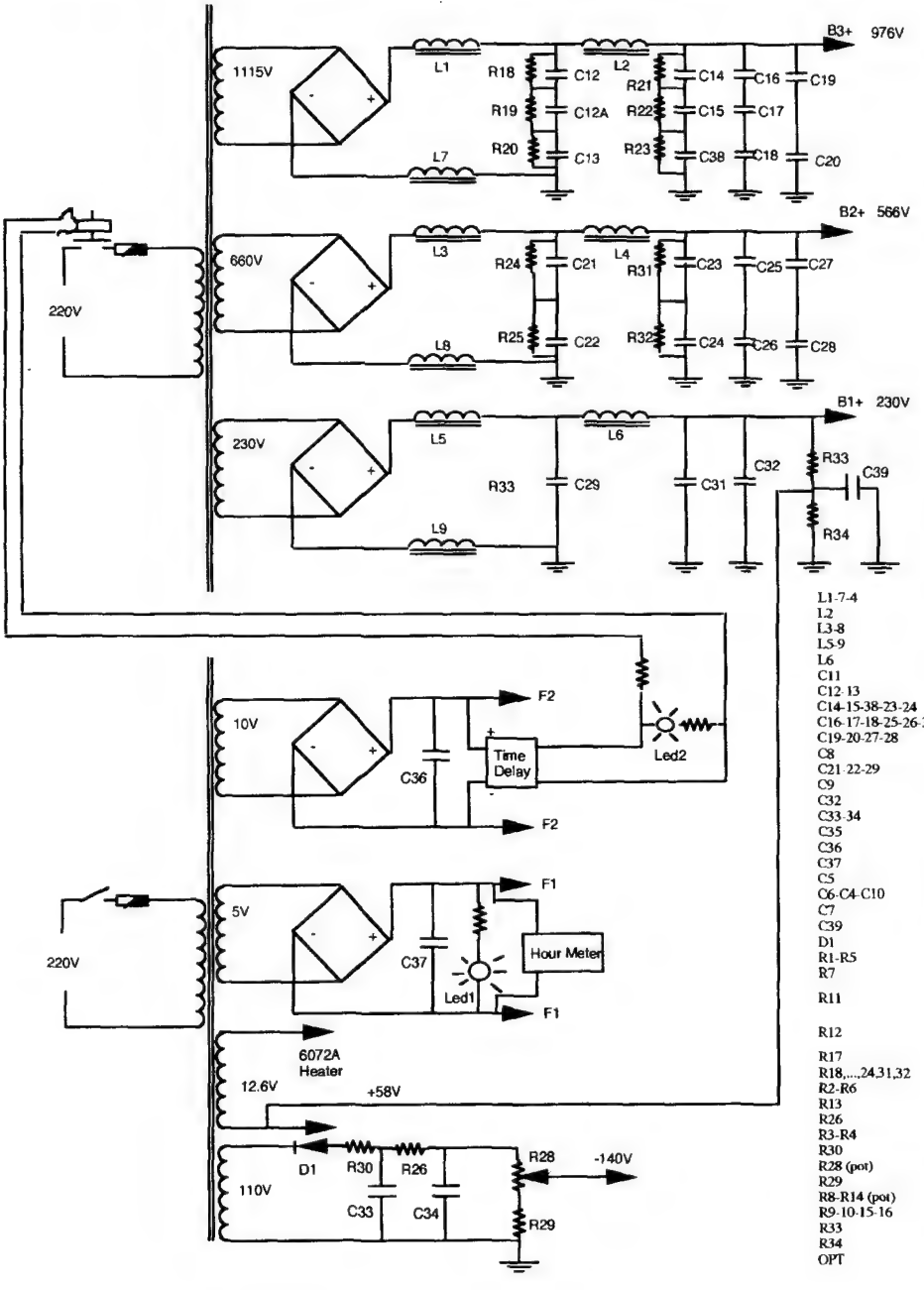
On paper everything looked fine but the most difficult part started when I received all these HUGE components. How on earth I was supposed to assemble them? It was going to be monstrous!

After a few days of acute depression followed by a heavy meditation period I decided to take everything to our company's workshop and get the help of our technicians for the chassis design and construction.

Nuance amplifiers looking good in their natural habitat, the Arduman listening room.







Nuance

845 SE Amplifier

by

Adnan Arduman

L1-7-4	6H / 200mA	Sowter
L2	12H / 200mA	Sowter
L3-8	3H / 200mA	Sowter
L5-9	5H / 40mA	Sowter
L6	10H / 40mA	Sowter
C11	0.01µF - 1600V	Hovland
C12-13	450µF - 450V	Mallory Type CGS
C14-15-38-23-24	47µF / 400 V	Solen
C16-17-18-25-26-31	6µF - 400V	MIT - PPMFX
C19-20-27-28	0.022µF - 600V	MIT - RTX
C8	5µF - 400V	MIT - PPMFX
C21-22-29	380µF - 350V	Mallory Type CGS
C9	0.01µF - 600V	MIT - RTX
C32	0.01µF - 600V	MIT - RTX
C33-34	200µF - 250V	Mallory Type CGS
C35	120µF / 400 V	Solen
C36	50000µF - 16V	Mallory Type CGS
C37	21000µF - 16V	Mallory Type CGS
C5	0.47µF - 600V	Hovland
C6-C4-C10	0.47µF - 600V	Hovland
C7	150µF - 400V	Solen
C39	20µF - 400V	Solen
D1	1A / 1000V	1N4007
R1-R5	274K - 1.0W	Vishay - VTA52
R7	3 x 1K0 - 20W	Caddock MP-820
R11	2 x 330R - 20W + 1 x 100R - 20W	Caddock MP-820
R12	1 x 10K0 - 3W + 1 x 4K7 - 3W	Caddock MS-223
R17	1R0 - 0.3W	Vishay - VTA55
R18,...,24,31,32	300K / 3W	Matsushita
R2-R6	1K0 - 1.0W	Vishay - VTA52
R13	100R - 1.0W	Vishay - VTA52
R26	510R / 1W	Holco H2
R3-R4	1K21 - 1.0W	Vishay - VTA52
R30	220R - 1W	Holco H2
R28 (pot)	10K / 5W	RS 163-151
R29	20K0 / 7W	RS 156-030
R8-R14 (pot)	100R - 2W	RS 162-776
R9-10-15-16	56R - 7W	RS 156-181
R33	75K - 3W	RS
R34	25K - 3W	RS
OPT	10K - 40W	Tango X-10S

The chassis is constructed from aluminum profile. Magnetic elements on my amp were banned like smokers on a US domestic flight. For the finish only black painted brass and wood are used. Soldered joints were made using WBT Silver solder and ground lines are connected in star fashion. Signal inputs are made from the sides in order to shorten the signal cable runs inside the amplifier.

The two monoblocks are built in mirror symmetrical fashion to allow both signal inputs to face each other and the hour meters to look to the exterior.

It took me two years to finish and test everything. The test results came out wonderfully with a perfectly symmetrical sinus at the output which gives approx. 25W on 8 ohm fixed load before clipping.

I also had to find them a name. NUANCE came to my mind as a very appropriate one: NUANCE is what gives the emotion to Music and meaning to life. It was lucky and surprising for me to discover that no such brand name was used by anybody else. Its model designation would be Op.65, 65 being my wife Eda's birth year. She was the one who initiated, supported and encouraged me at every level of the project.

The subjective listening results are also very satisfactory: silky, full bodied midrange, trebles detailed and free of harshness or edginess, extended and fairly controlled bass (if not on par with best solid state and/or push-pull gear). Nothing seems tiring at any duration. Maybe as a result of this (or because of the increased pleasure) I noticed that I am now listening to Music for longer periods.

I can comfortably declare that I achieved my goal of bettering my ARC Classic 60 amp which sounds thin or lean in the mids like a solid state compared to NUANCE. Furthermore, the ARC seems to be less involving and less musical. Subjective tests were carried out using ProAc 2.5 speakers.

One of my "golden eared" friends declared that it was the most musical amp he had heard to date and another one (who builds kits) suggested I write about my project in *Sound Practices* as he thought it was a success story.

So here I am. It's a pity I can only transmit the story but not the sound but anybody who is willing to visit my wonderful country, Turkey, is most welcome to my home for an audition. For appointments kindly contact the undersigned.

Adnan Arduman
adnana@turknet.com.tr

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12AX7WA/ECC803s Tesla (Slovakia) gold pin. Very close copy & similar sonics of rare Telefunken ECC803s. Not just another tube that "sounds like" an ECC803s! 24.95 ea (standard Tesla 12AX7 also available-6.95 each)
12AU7/ECC82 Tungsram (Hungary) Can't find E German RFT 12AU7 except at riduculous prices? These look & sound similar but stay quiet much longer than E German tubes. 7.95 ea
12AU7/CV4003 Mullard British military. Lower output imped than std 12AU7 19.95 ea
12AT7/CV4024 Mullard British military, "double-flange" construction 19.95 ea
KT88 Tesla Close copy of Genelex tube, next best thing & much less expensive than US or British 69.95 per matched pair
KT66 Blue Glass Chinese Sure looks cool!
350B China Handles up to 600V.Interesting replacement for KT66, EL34, or EL37. Internally looks like real Western Electric 350B, not like 6L6 or EL34.
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6V6-GT/CV511 British made by STC (UK equiv of WE) British military issue. 1960's date coded. 14.95 ea
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6922/E88CC JAN Siemens military. Gold pins, NATO issue, datedcoded 1962 24.95
CV378/GZ37 Mullard mil Large bulb sub for 5AR4, WE422A 17.95 ea
'50, National made by Cetron (USA), 1994 date code. Looks like a 300B! $125 ea
5691 Sylvania, inside same as RCA, butblack base, $19.95 ea
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Casual Reactions



by Herb Reichert, Audio Note NYC

The Dream I Want

If your ears see,
And your eyes hear,
Not a doubt you'll cherish —
How naturally the rain drips
From the eves!
Bujutsu Sosho

Sound Practices is really a lifestyle publication, like *Low Rider* or *Chevy World* and the editor is really a lifestyle consultant. And you know what? That really is a picture of me in the drawing above my column. That's me in one of my dream lifestyles. I haven't started wearing a bow tie but right now I'm sitting here, smoking my pipe and listening to 1/4 track tapes on a Revox G-36. I want to be the calm poet listening to the voices in the wind.

I believe you are what you aspire to be and the only way to discover your aspirations is to travel a few untraveled roads. Me? I have chosen to find my future self by following the various paths that music and art lead me down. Lately, I have been exploring alternative source material like tape and 78s and I have a good feeling about where it is leading me.

Sound Practices appeared at the dawn of the alternative hardware revolution. Its program is to encourage new ways of thinking about audio engineering and new ways of listening. For me, this magazine is the magazine of suggestion. Here is an idea, take it and run. Then get back to us. Tell us what you have learned. Now I am beginning to think it is time to reconsider WHY we build audio components.

I believe that now is the time to take a holistic view of the audio design process. The tea ceremony of playing tapes and discs, the processes of developing more effective amp/speaker combinations, the creation of a beautiful audio installation, the laying down of wires! To build a shrine in your home. To install your speakers and light them effectively. You didn't know this? The lighting of audio components and the lighting of the listening room are every bit as important as the circuits you choose. Home building must be a complete conception!

If you are to pursue the Ultra-fi DIY aesthetics suggested in *SP*, don't do it to build boxes to save money, build a temple for music! Try to see the home construction of hi-fi in architectural and artistic terms. Create a secret place: a tree house or a monastery. Use your time, your skill, your personal resources, to create a magic world. Aim for intensity of experience. Don't just go in the basement to isolate yourself, use these ideas to connect yourself to the forces and laws of nature. Use these projects to broaden your intellectual and social horizons. Use these suggestions to unleash the artist and scientist within you.

The home builder is the only one that operate on this level. The big audio companies cannot compete with a man inspired to reinvent himself.

There are three processes that make the music hobby. First the creation of the playback system and the integration of this system into the home environment. Second, the selection and acquisition of the music software. Third, the tea ceremony of listening.

To be successful at building an amp or speakers, I maintain you must PICTURE, in your mind, how you will look and how you will feel playing discs. I mean how it will feel to put the disc on/in the player. I mean how you think you will look in the room lighting, standing in front of the player and between the speakers. I mean try to imagine how you will feel putting on the disc and sitting in the chair, dreaming and carrying on, in the new world you have created. This is your time machine, your sanctuary. This is your religion. You are the wizard, the movie director, the conductor, the mad scientist! When you create your own music system, you create your own new culture. I really like the feel of playing 78s. It takes me somewhere.

If I could be remembered for only one contribution to audio it would be this: How the system looks, how the electronics and speakers interface with your room and lifestyle, how they are placed and how they are lit, is THE most important thing you can consider when planning a home building project. Please don't just build a box full of tubes and stick it on the carpet of your living room.

Create a PLACE to go. Create a personal RITUAL. Integrate the process of soldering with the process of listening. Do not separate the process of building and planning from the process of living. Let the gluing and soldering lead you to notice the birds singing and the wind in the leaves. Create a hi-fi that reminds you to listen to the rain falling.

I can only speak for myself, but nearly thirty years of building audio has forced me to finally reflect on the why more than the how. For me, audio is about becoming a more peaceful, cultured and reflective man. It is simply a process. In my dreams, I see myself as a lone Zen scholar sitting in a little wooden boat, fishing and painting pictures. When I get tired, I take a nap!

My daily reality is somewhat different. I talk on the phone, I pack boxes, I do bookkeeping, I solder a little but I rarely get to sit, puff my pipe and listen to music. When I do, I really, really want it to feel special. I want to go somewhere and be someone new! The few hours I get to be alone and listen and dream must (for now) be a tangible and rewarding substitute for what I really wish I could be doing.

My personal explorations in audio are motivated by a strong desire to make my musical moments...transcendental. It is a path. The act of placing a 78 on a Thorens 125 and listening to Fritz Kreisler play Paganini, in tones that make me cry, is as close to the Zen poet's lifestyle as I can get...for today. This is why I pursue basement audio.

For each of us it will be different. I think my friend J.C. time travels, becoming the early 'dark lantern' alchemist one day and the future cyber-poet the next. For my friend Rio, it is sexual. He wants to lay his head on the breasts of Julie London before he falls asleep. For others the path is about connoisseurship, becoming a person of

higher appreciation and deeper sentiment. Any reason or plan is good. A magazine like *Sound Practices* can open doors and give you a peek at what's outside the house you are living in, but you will have to choose which path you walk down first.

Uchida Makes a Transition

In issue #11 I took you to the den of Uchida. We had miso soup and 755As. I promoted April Audio.

Well, I am sorry to say Uchida is not here for the spring rain in New York City. He died just after the article was published. Uchida was the Cheshire smile behind the Triode movement in New York. He was a good teacher and an inspiration. He was a great friend to any kind and genteel music lover. He galvanized a circle of alternative audio people and he reminded us never to get too technical. I wish I were more like him.

Professional-quality line conditioning

by: VansEvers

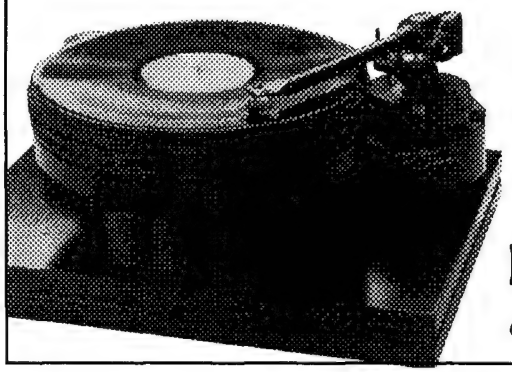


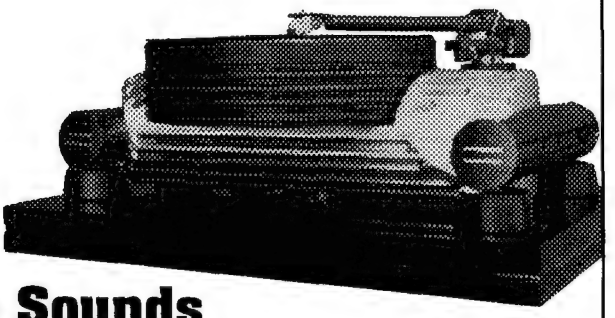
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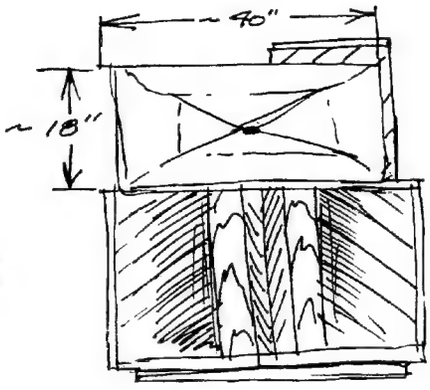




Renaissance Sounds

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From the Backwoods



Yet another way to play strings (and kick butt) with a few watts

by The Baroda Bard

Pressing toward musical ecstasy with a two-way and a woofer

I've been playing with horns in the world of pro audio since my employer, Electro-Voice, got into the business circa 1974, later to become a major player beyond all the grand originals (Western Electric, Altec, JBL, Stephens, et.al.). I've hooked up and voiced more two, three, and four-way horn systems (sometimes mixed in with direct radiators) than I can shake a stick at. In auditoriums, trade show demo rooms, hotel rooms, mono, stereo. . .

I've never had much trouble making them sound enough like music to want to bring one home to my stereo someday. Someday. Right now I'm listening to a system at home that I've been working on since November 1994. See the pictures and the system diagram below. We are having a blast and the emotional chills are abundant.

My buddy Will calls the system "nouveau retro hi-fi." It doesn't look anything like Lowther cones, Altec multicells, A7s or A5s, Tannoys, Klipschorns, EV Patricians, or WE goodies, or the modern Eurythmies and Edgarhorns. All of the above are relatively mainstream now. What I've been listening to with so much pleasure and excitement is the way of only me and Ray and Takane-san in Tokyo. Essentially discovered beyond my living room, perhaps never to be discovered, which is OK.

The system is multiamped, horn-loaded from 80 Hz on up, and is easily powered by a few watts– and not just for Haydn string quartets. To give an idea of the territory we're working in, we have closed out late-night parties with the 80 rank Sanfilippo Wurlitzer, 32 foot stops and all, at the same 108 dB broadband maximum long-term average level I measured in the hall.

Or how about Hank Williams, Jr. doin' "Ain't Nobody's Business" at 112 dB? And the system isn't even topped out yet. As for the string quartets, *they* top out at 79 dB maximum average level experienced in the sixth row.

I got into the SE 2A3 thing because I didn't want to pay the 300B price, but come on with 45s, 300Bs, or any old PP thang you found in Grandma's attic. I have a few 20 to 30 W push-pulls that I put to good use and they work fine, aside from being total overkill in the watts out department.

I like an occasional, very robust pipe organ with my cognac, so there's a high-efficiency (97 dB 1m/1W) vented direct-radiator covering 25 to 80 Hz. This is an EV DL15W 15" woofer in a 3.2 cubic foot box tuned to 28 Hz, a so-called B_6 alignment that requires an underdamped (Q=2) high-pass filter at 28 Hz to flatten the overall system frequency response. You can get the same response without EQ if you double the box size and maintain the same tuning frequency.

Basically, it is a Thiele-Small on the computer style design, which takes a lot of power relative to horns. I use an old pair of Mac MC40s on loan as low bass amps.

So, here's my current recipe for approaching musical ecstasy with horns in stereo, using only a few watts.

1— Keep it basic, cinema-style

Two-way configuration, 500 Hz crossover. Compression driver and horn above 500 Hz. Fully horn loaded cone driver under 500 Hz.

The big bass horns are a creation of my late very best friend Ray Newman, who died suddenly in February of 1996. Total surprise to me and I wasn't prepared to learn how much I depended on "talkin' to Ray" and slipping his latest LF horn design into the old system. This prototype pair of horns develops a whomping 106 dB 1W/1m and is solid from 80-500 Hz using EV DL10X 10 inchers.

See John Stronczer's article in Issue 11, *Voice of the Theatre Chez Nous*, for an excellent treatment of horns and woofers that sound like music. It was very much a pleasure to see some real speaker basics outlined. Bottle heads interested in getting into speakers should take heed!

2— Select a big, dead-stiff HF horn that loads the driver pretty much like an old-fashioned, straightforward exponential horn but with constant dispersion over its operating range of 500-20,000 Hz.

Horns with this characteristic are called "constant directivity"(CD) horns. These devices have a bad name in some audiophile quarters. John Stronczer, for one, rightfully warns against modern CD horns with abrupt flare rate changes and non-optimally sized mouths, including too small.

Indeed, constant directivity is not a natural thing for a speaker to do, even though horns can be designed to produce this characteristic. Often in the world of pro sound, driver loading performance is compromised to achieve the desired directional results, with associated detrimental sonic effects.

I believe that given the realities of typical listening room acoustics, controlling the angle of radiation with stability across the frequency range – say over angles of 90° x 40° or 120° x 60° –creates an "open" or "transparent" quality that is very revealing of a stereo recording's inherent character.

A side benefit is being able to step out of the magic listening position, say to finish dinner in the kitchen alcove, and still being able to hear most of what you hear in the magic spot.

Electro-Voice developed the first CD horns in the early 1970s, which otherwise behaved like the best classic exponentials before them. The EV HR9040 and

HR9040A (c.1974-85) offered extraordinarily constant 90° x 40° dispersion across the bandwidth without messing up the driver load.

Technical proof is in the very uniform impedance vs. frequency response, suggesting a lack of bad-sounding mouth reflections. The sine wave response curve was also very smooth, without the up and down nasties that most advertising departments like to keep hidden in the closet.

Executed in brilliant white fiberglass, the smoothly sculpted shape of the HR9040A is a sight to behold from the listening position. Its physical presence is even more substantial than the 1505B multicell—overall dimensions of 17" x 40" x 23" hwd for a huge mouth area of nearly five square feet!

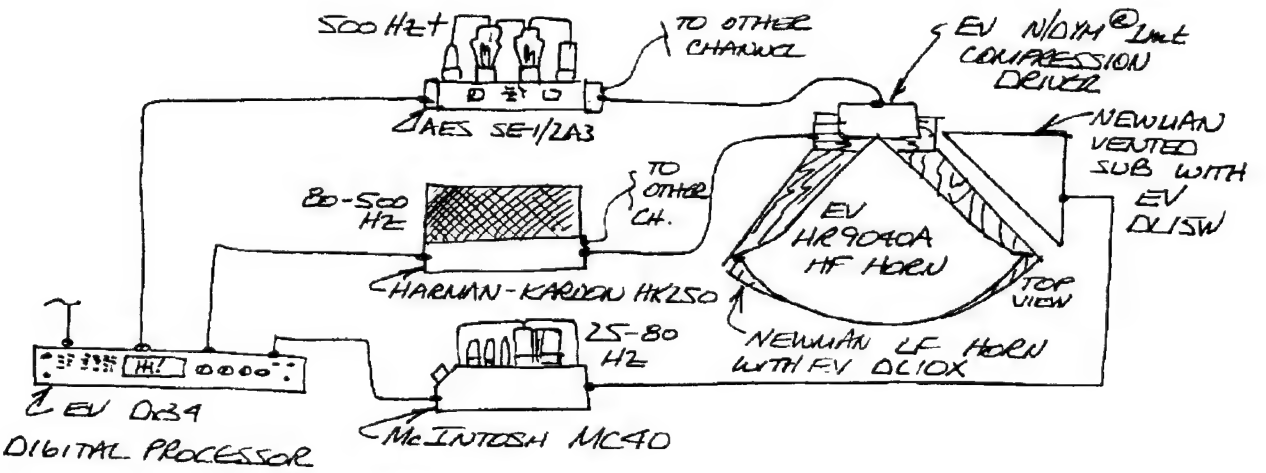
One benefit of the large mouth is the horn's ability to maintain its rated 90° horizontal coverage angle down to the crossover frequency of 500 Hz. A horn needs to be at least 27 inches wide to do this. Smaller horns can be 90° at higher frequencies, but at some point way above 500 Hz, they will "balloon out" and approach omnidirectional (360°) response as frequency decreases.

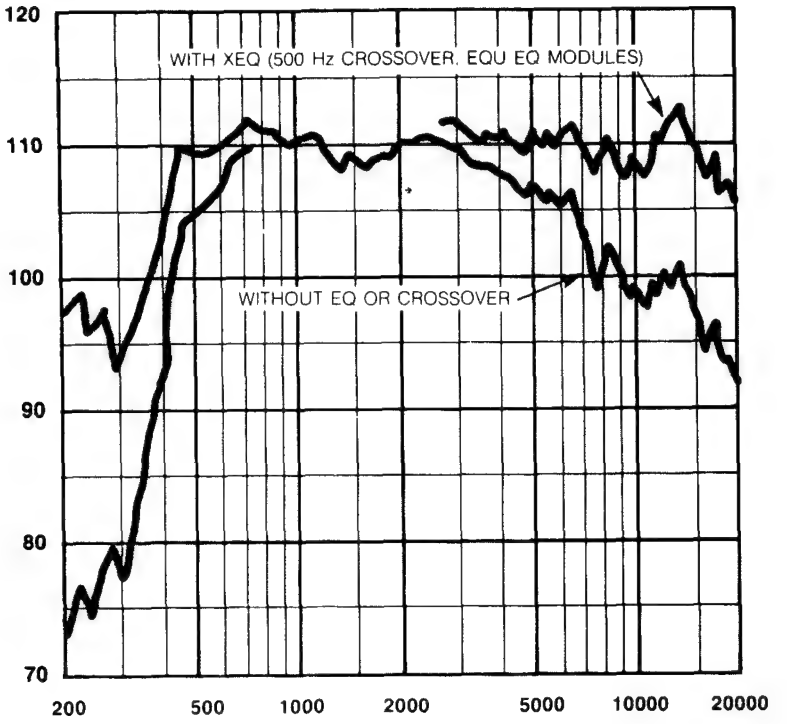
The HR9040(A) throat size is 1.3 inches and the flange has holes for EV 1.3 inch drivers and Altec 288s, 299s, etc. The





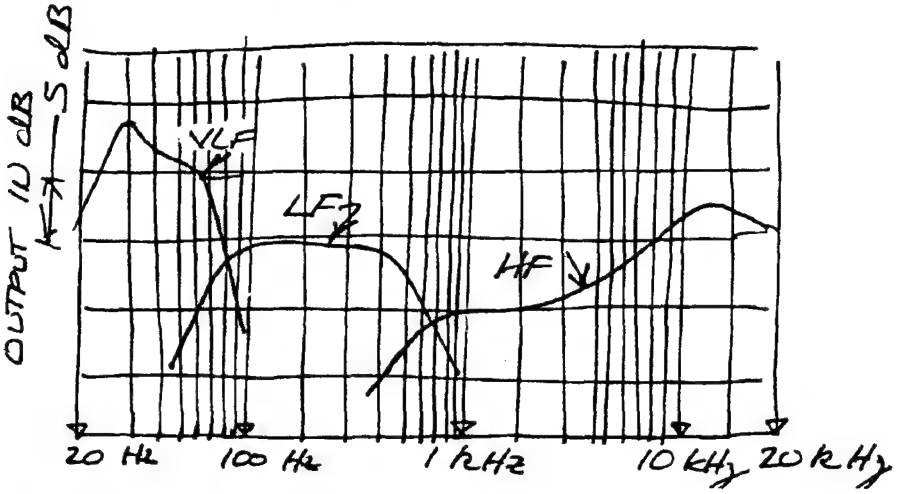
The Bard's "mostly" horn-loaded backwoods ecstasy system. Bass below 80 Hz is handled by a direct radiator 15" EV woofer.





Unequalized axial frequency response of N/DYM-1 high-frequency driver mounted on an EV HP9040 constant directivity horn demonstrates a uniform 6 dB rolloff above 3000 Hz or so, close to the theoretical maximum.

Active or passive EQ can be used to obtain an essentially flat frequency response out to 20 kHz. Not being one to miss out on a good shortcut to musical ecstasy, the Bard uses the latest tool of pro sound, the digital signal processor.



Approximate digital EQ transfer function for a flat in-room response with The Bard's Backwoods Two-Way + woofer



Electro-Voice N/DYM-1mt
High-Frequency Reproducer

Neodymium alloy magnet system, titanium diaphragm with edge-wound aluminum voice coil.

Available in 8 and 16 ohm versions..

Minimum crossover frequency 500 Hz

Throat diameter 1.3 inches

Sensitivity 111 dB@1m/1W(500-5000 Hz on HR9040A horn)

---

slightly different exit diameter of the Altecs (1.4 inches) is of no acoustic consequence.

I started out with a later-generation EV "small format" CD horn that I liked for pro applications and the Klipsch K-400 midrange horn. The small CD horn just didn't sound right, although the dispersion was great. The K-400 sounded very good but beamed like mad– a characteristic that, in the end, made me want to go back to my old speakers which didn't beam.

When I tried the big HR9040A, there was no contest. It was like removing a barrier in the room between me and the performer. Immediate, open, and right there.

The HR9040 and HR9040A are the same basic design but the "A" traded a vertical front stiffener for radial stiffeners and used a simpler-to-produce throat detail that had the side benefit of smoothing response a bit above 10 kHz. The story of the EV HR horns is contained in Don Keele's 1975 Audio Engineering Society preprint, "What's So Sacred about Exponential Horns?" Write The Bard c/o SP for a copy or e-mail me direct @ jlong2@compuserve.com.



The Bard's latest system uses two EV Dx34 digital signal processors for crossovers, parametric and shelving EQ, and signal delay for shaping loudspeaker response. The defunct de Forest Audion from the Bard's dad sits atop a single Dx34. The Klark Teknik DN27A one-third octave EQ was formerly used for the job.

3— Use a compression driver with performance close to the Newman criteria in acoustic power output vs. frequency.

One of the frustrating realities of all compression drivers is that the efficiency of a well-designed driver falls off at about 6 dB per octave as the frequency increases beyond 3 kHz. In short, there is no way around this phenomenon which is caused by physical realities like air squeezing through small slots and friction in the diaphragm suspensions (see Bard and Ray, *SP #7*). The best you can do with a real world speaker is 30% efficiency in the mid-band, dropping off with increasing frequency, and the rest of the power turns into heat.

The top drivers from companies like Altec, JBL, EV, TAD and so on perform at a level approaching this theoretical maximum. In order to get a flat acoustic response, you can use a horn, such as the Klipsch K-400, employing a geometry which results in a decreasing coverage angle with frequency. This gives a sort of "acoustic equalization" for a lucky on-axis listener, but listeners off to the side of the horn don't get the highs. And the music can seem oddly "closed in" to me. Not my idea of cool! What to do?

The other way to get a flat response where you're listening is to use EQ. With a CD horn, obviously, it's the *only* way.

4— Use one of the latest tools of pro audio—a digital signal processor—to EQ for the Newman Criteria and artfully integrate the woofer and tweeter in a biamp configuration.

To make the system sound right to me, I hook it up the way I would at work. Ten years ago, we had 1/3 octave EQs and active crossovers. Today, it's digital processors with adjustable crossover, parametric EQ, shelving, and signal delay to get the drivers in step without having to have equal path lengths to the listener.

The way I see it, life is too short *not* to use the most effective tools at my disposal to tune up a horn system. Essential tools in my arsenal include a good flat lab mic and a spectrum analyzer, plus extensive EQ and active crossover facilities.

I know what you are all thinking: "How could he listen to that evil digital processor?" How could I cut up my nice analog signal and try to piece it back together before I send it to a neat little SE triode amp? What you really mean is how could I listen to it and get anything like musical ecstasy out of the deal?

Well, all ya gotta do is come over to my house some night for dinner and hear Dinah Shore and Andre Previn doing "It Had to be You" followed by Les Brown and his big band at concert level, and you might get hooked—Capitol's late-1950s recording style in the tower at Hollywood and Vine might have something to do with it. We do country, rock, and Carl Orff too.

Sure, it would be possible to do the compensation with analog electronics, resonant



Get back, Jack! The Bardmobile out prowling the woods for more lumber.

circuits using caps and coils, but there's a lot to be said for the ease of dialing it right in with the processor. Here's a brief rundown of the setup procedure I use:

1– Start by EQing the in room response of each speaker/amp combo operating alone for a flat response 6 dB down at the crossover point. A pink noise source and one-third octave spectrum analyser are what I use, although software is available to adapt your computer to this worthy purpose. I also like to roll off the lowest woofer below its bandpass to keep infrasonic junk the speaker can't reproduce from muddying up the sound.

2– EQ the HF horn for a flat response above 500 Hz measured on-axis with the mic about three feet away (to minimize room effects). The curve may vary a bit in a more distant listening position, but the direct field will be essentially flat and the ear/brain combo keys in on this.

3– EQ the bass horn and sub and adjust the LF/HF balance *at the listening position*. Efficient bass speakers "put a big handle on the room" and, thus, the room– walls, floor, and all– puts a big handle on them. Deal with that at the listening position.

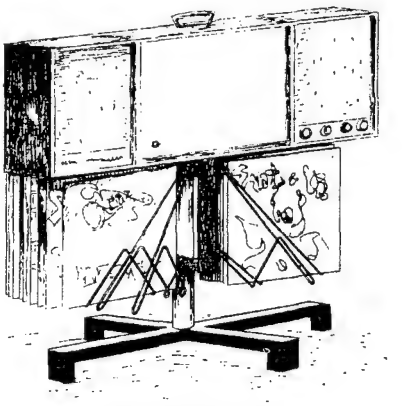
Of course, it is possible to go too far with compensation. If you try to EQ out every little bump in the response, you can squash the music out of it. Plus, if you can cancel out all the narrowband variations in one position, when you move the mic a bit you'll just have another set of small variations to contend with. In my system, a gradual broadband HF boost does the trick.

4– Adjust for path-length differences from the speakers to the listening position with the signal delay feature of the Dx34. Delay is adjustable in 20 microsecond increments, equivalent to a distance of about 0.3 of an inch. Close enough for me.

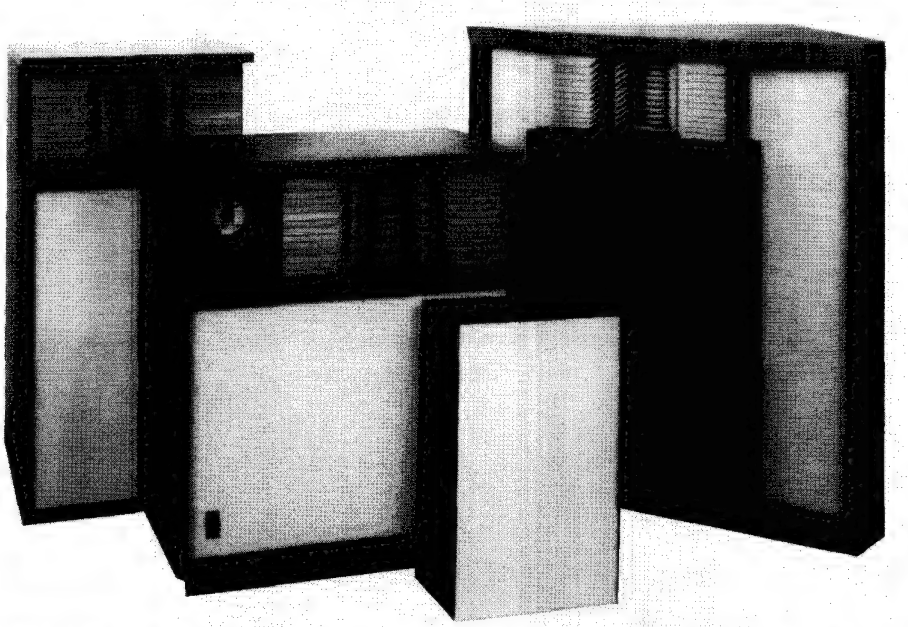
Looking at the system from the listening position, the subs are nearest, meaning their signal arrives first. The HF drivers are about 24 inches farther away, and the drivers in the folded LF horns are about another two feet away.

To adjust delay, I set the SPL of each speaker operating alone to be equal at the crossover frequency using a signal generator. Next, I turn them both on, inverting the polarity of one driver and advance the delay until the sound level at the listening position begins to drop then increase again. At the null, the signals are exactly 180° out of phase, causing a cancellation of the output. Restore the correct polarity of the inverted device and there you have it, perfect, instep summing at the crossover point.

It took a few years to get everything lined up the way I have it now, but almost every night, we sit down to enter another world—MUSIC. We don't hear horns or crossovers, even with the big speaker rigs only eight feet away. And we've had enough friends over to know that our great happiness is transferable. Musical ecstasy? Go for it– I think we've got it!



Horny for horns?



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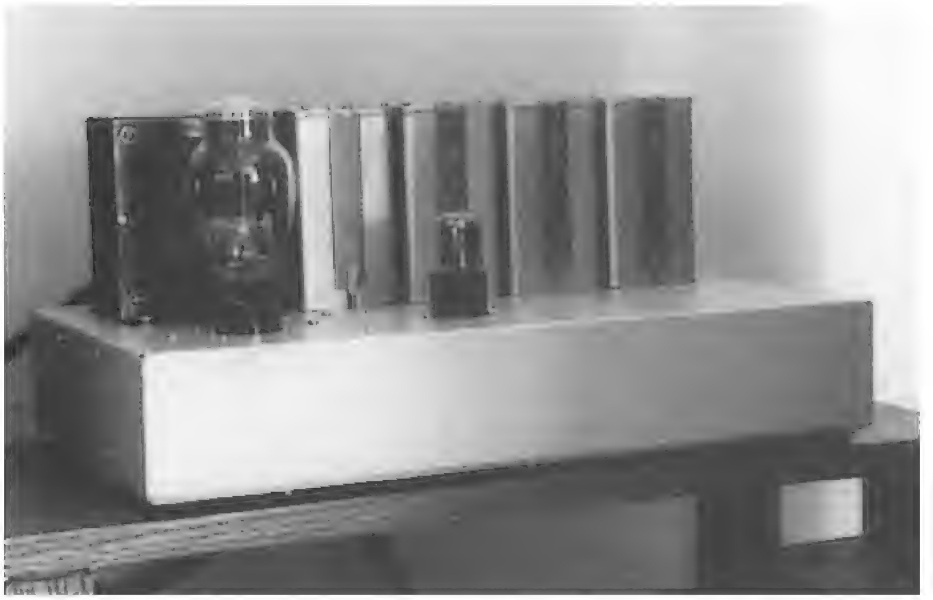
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Homebrewer of the month

Bruce Berman of Long Island, NY



Bruce's homebrew 300B SE mono amplifier audio chassis

One look at Bruce Berman's carefully hand crafted triode and horn music listening system is all the evidence we need to recognize Bruce as a Tube Man of the first order. Hey, good job!

What better evidence of dedication and commitment to the craft can there be than this monument to the gods of music, not to mention the gods of the homebrew art?

A system like this is one man's audio dream made real through hard work, so naturally Bruce has a great deal of pride in his audio setup—as well he should, because he turned a pile of old cast off junk and raw materials into a custom high-performance music system unlike anything you can buy anywhere. There's only one way to get a system like this—if you want one, you've got to build it for yourself.

As far as circuits go, Bruce swears by time-tested, carefully engineered, simple circuits with the best parts that he can buy, scavenge, or recycle, selected for sonics, not fashion. Although he does seem to have a certain fondness for old US-made industrial and broadcast parts, if the new stuff sounds better, the cool old parts don't make the final cut.

He experiments with circuits using breadboards to perfect the operating points and evaluate component sonics. After he knows exactly what is going in, then he does an exacting mechanical layout with calipers and graph paper. The clean look of Bruce's equipment owes a lot to his "measure twice and cut once" philosophy.

It's obvious that a lot of hours and hard work went into putting this system together. yet Bruce is super-content these days because he feels he's arrived at a lifetime system. Indeed, aside from tubes, most of this simple and solid equipment could easily last several lifetimes.

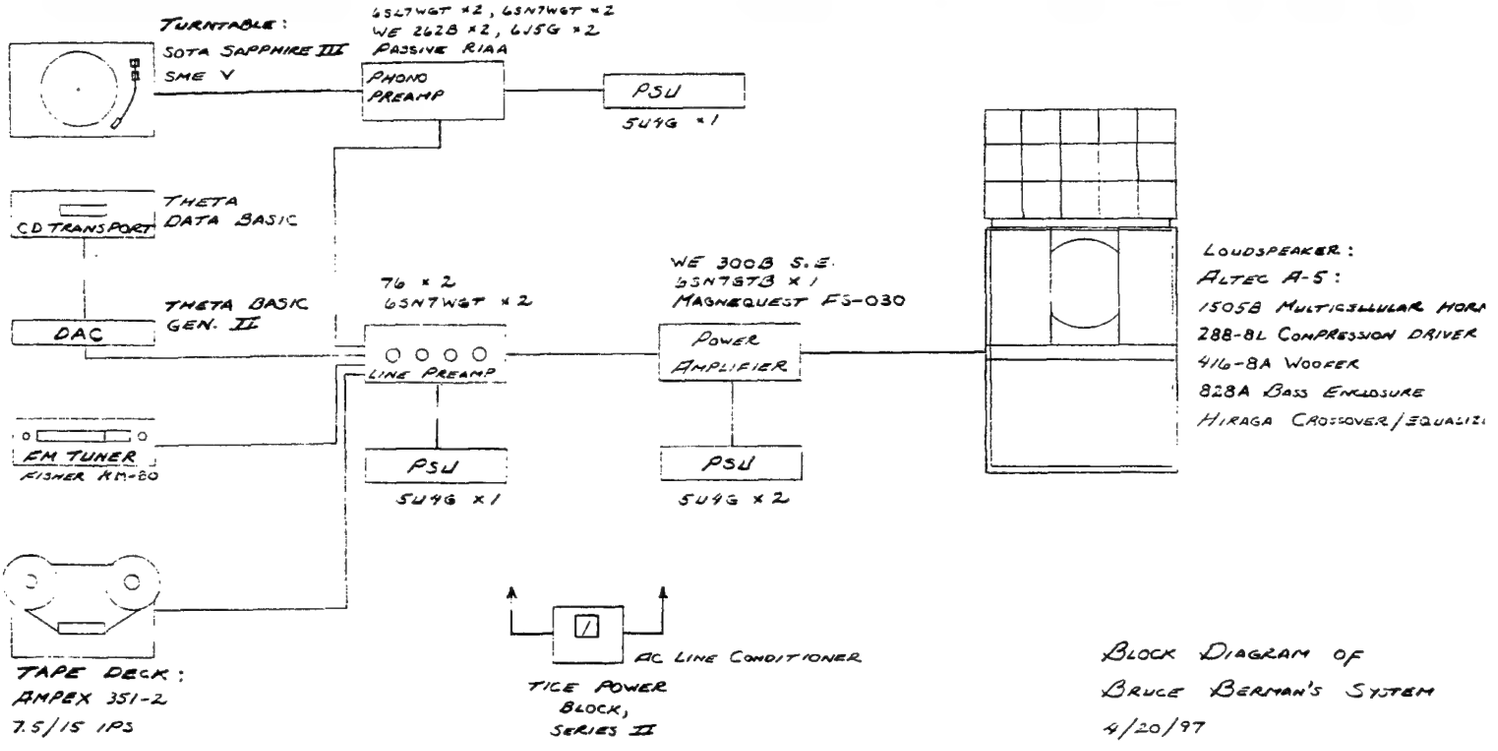
A system like this is an investment in the future but it draws heavily on the past for lessons and inspiration. It is obvious from the way this gear is put together that Bruce has a real appreciation for the classic American industrial electronics tradition.

They don't build them like that anymore, and perhaps they haven't since World War II, but Bruce is still doing it. Keep the faith, brother!



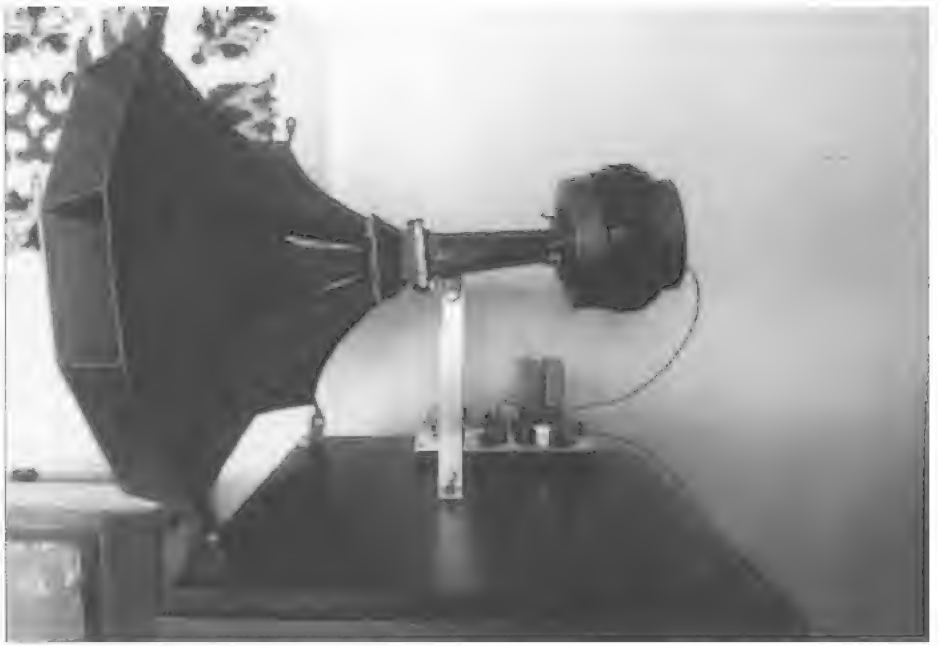
Tube rectified , choke input power supply for one 300B mono amplifier. Bruce believes that the power supply should always be much heavier than the audio chassis—in this case, the PS for each channel weighs a chunky 75 pounds!

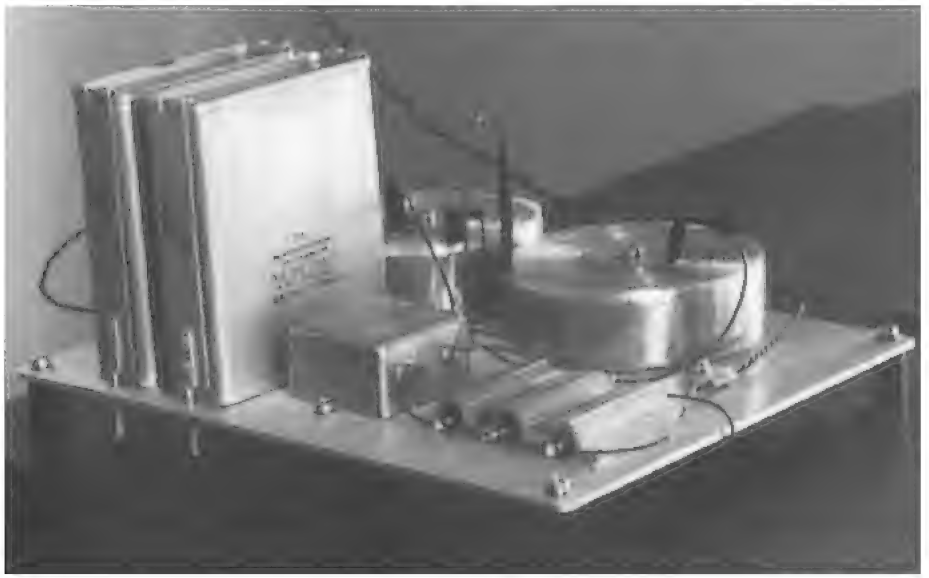




Block Diagram of Bruce Berman's System 4/20/97







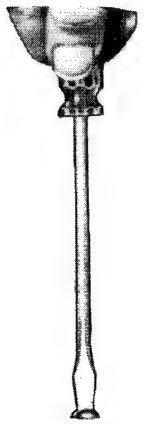
Fine attention to detail in layout, construction and parts selection is evident in Bruce's Hiraga-style EQ crossovers (see Stronczer, SP #11) for his Altec A5 "Voice of the Theater" loudspeaker systems.

Vintage Cornell Dubilier oil caps, Solo CFAC foil inductors, and Dale non-inductive, aluminum-cased, power resistors definitely looks like it ought to sound good. Bruce highly recommends the EQ crossover to VOT users, saying that the speakers really "clicked in" for home music listening with the new x-overs.

Being the consumate tube man that he is, Bruce is not content to limit himself to the 20 Hz-20 kHz frequency range. Pictured at right is his all "hollow state" amateur radio station, featuring a homebrew AM transmitter using a 4-400A modulated by a pair of 833A (behind the glass window in the center rack), capable of 1 kilowatt of broadcast-quality Class B audio. The speech amplifer driving the modulator is a Dyna ST-70.

Bruce definitely knows how to keep warm during those long New York winters! If this guy turned on all of his tube gear at once, the line voltage would sag all over the neighborhood!





My Homebrew Type 76 Preamplifier

by Bruce M. Berman

Very few things compare with the thrill of designing, building, modifying, and most importantly, listening to audio equipment that sounds utterly entrancing and that you built with your own hands. You will never experience this deep sense of accomplishment by buying an Audible Illusions preamp from your local audio salon. I am a strong proponent and practitioner of the almost lost art of homebrewing your own electronics gear.

J.C. Morrison wrote some time ago that, "if you change as a result of listening to your hi-fi, then the hardware is doing it's job." I completely subscribe to this philosophy of combining art with creative engineering, in that it makes for a more well-rounded, purposeful, and interesting lifestyle, and this is only further enhanced when you build your rig yourself.

The design of this line stage preamplifier began with the realization that the overwhelming majority of recorded music, be it LP or digital, is very mediocre in terms of technical quality, and while this is certainly no revelation to most of us, I needed a system which would play most of my records all of the way through. Having a harsh, unnatural-sounding system that will only play Cheskys, Audioquests, Living Stereos, and other audiophile-grade recordings to our satisfaction, is foolish and deprives us of the emotions to be realized from the tremendous quantity of recorded music that exists. This has been discussed most eloquently by Herb Reichert and others in these pages before, so I will not elaborate any further, only to say that I too am in full agreement with this attitude.

In my household, digital and analog (LP and reel-to-reel tape) playback generally peacefully coexist, although I spend considerably more time listening to LPs. I prefer the modular approach to preamplifier design, in that my phono and line stages are built on completely separate chassis, and this modularity provides the serious enthusiast with considerable flexibility in the design and configuration of his system.

For example, I am currently building a new phono section, and my system doesn't have to be completely out of commission because my preamplifier is being torn apart. Most importantly, separate components provide considerable electrical isolation and freedom from interaction between stages, and the sonic benefits to be derived from this design approach are significant and well known. Then too, line preamps are a relatively new phenomenon within high-end audio, brought on because a lot of listeners enjoy only CDs, and have no need for phono playback electronics.

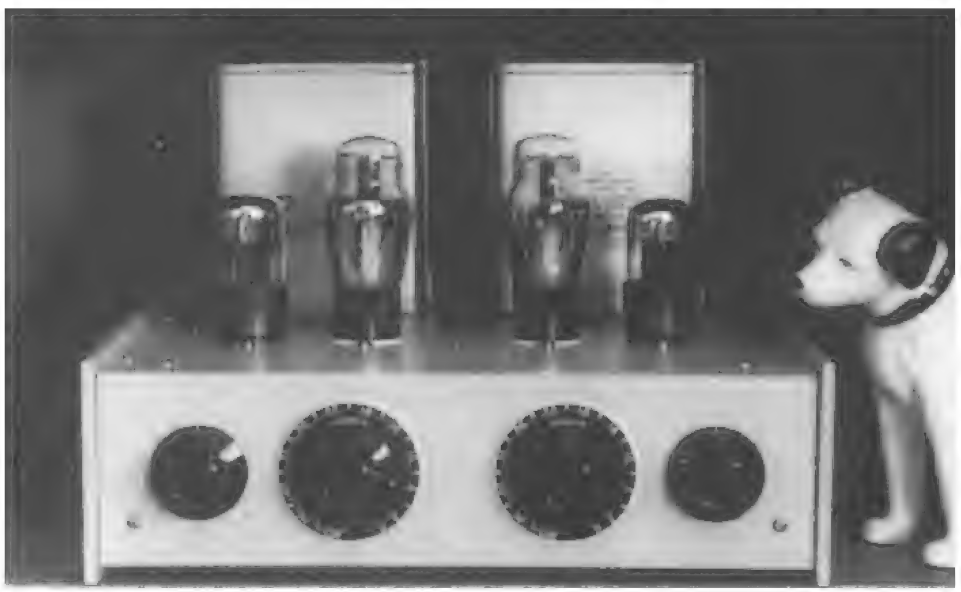
Built the way I describe it below, this unit sets very high standards for purity, naturalness, ease, speed, and all of the other criteria currently used to evaluate high-end audio reproduction equipment. When mated with a phono stage of comparable quality, you can fully expect superb results.

Finally, let me say this: When using directly heated triode single-ended amplifiers, horn-loaded loudspeaker systems, and no negative feedback anywhere within your system, all of the rules change. Before you begin the full-scale construction of this unit, you may wish to breadboard it first to ensure that the sonic results are to your liking with your system. Even if you decide not to build this preamp, I hope that some of the construction techniques and component parts recommendations that are described here will be of value in building your own audio creations.

Preamplifier Topology

This line stage unit is really nothing more than my own personalized version of a simple, mature, well known and certainly tried and true circuit which has been used by a number of experimenters for many years. It consists of a single 76 indirectly heated triode in an anode follower configuration, direct-coupled to one-half of a 6SN7WGT connected as a cathode follower to the amplifier load.

The choice of the 76 was largely motivated by the positive comments regarding this tube by J.C. Morrison and my good friend and ultimate audio experimenter, Tom Weiss, among others, who have utilized the 76 in various preamp and power amplifier input/driver stage topologies. For those who have never heard the 76, it brings an incredibly open, clean, clear, natural, and fast sound to the listening room. I believe



the cylindrical plate structure has much to do with the beautiful sound that 56s and 76s can create.

This tube is certainly one of the most linear indirectly heated small signal triodes ever made and traces its lineage back to the 1930s. The 76 and its 2.5 volt filament older cousin, the 56, enjoyed wide popularity as an inexpensive yet high quality voltage amplifying device in many consumer as well as commercial and military applications.

Many radio sets manufactured for the home from the 1930s thru the early 1940s used these rugged little ST-shaped triodes in their audio stages. Fortunately, 56s and 76s are still fairly common, having been made in significant quantities for many years, both as the standard commercial as well as JAN/military versions.

The 6SN7 probably needs no introduction, as the highly linear amplification characteristics of this tube are well known. The real advantage of the 6SN7 in this circuit lies in this tube's relatively low plate resistance and moderate transconductance, which results in a low source impedance, making this device ideal to drive a difficult capacitive load such as an interconnect cable when terminated in a typical 100K ohm load impedance.

I have gone the full route of playing around with the so-called "designer" or "boutique" tubes, such as the ubiquitous 12AX7, 12AT7, and 12AU7s manufactured by such well-known and revered companies as Telefunken, Mullard, and Amperex. These companies manufactured some of the best sounding low microphonic tubes within this classic family, and they have now become very scarce and expensive. I say let the Jadis and Audio Research enthusiasts enjoy using them.

There are many tubes out there that are readily available, reasonably priced, and yet leave these famous and now highly sought after tubes totally in the dust from a sonic standpoint. The 56, 76, 6SL7, and the 6SN7 are but a few of these examples.

The 6SN7, 76, and 12AU7 are generally somewhat similar in electrical characteristics, but that is where the similarity ends. After auditioning these tubes in my system when utilized as resistance-loaded anode follower voltage amplifiers, the 12AU7 would be the first one to go. Its lack of clarity, control, and that essential characteristic, tempo or pace, becomes immediately apparent when compared to the 76 or 6SN7. The 12AU7, and I don't care if they were made by Telefunken or anyone else, always seem to impart a tired, sleepy sound to the musical presentation.

As mentioned earlier, the 76 has a certain sense of refinement, pace, and excitement, that makes it almost mandatory to employ this tube as the voltage amplifying element in our line stage section. These attributes will really shine in terms of the overall sonic character of the preamp. The 76 is biased at an operating point which results in a quiescent idling current of 6.0 milliamperes at a plate voltage of 200 VDC, and this puts the operating point of the tube way into the linear region.

Forgive my lack of enthusiasm for the currently much in vogue SRPP and mu-follower circuits, but I have never found the sound of these designs to be much to my liking, my experience being that the sound tends to stray from the natural and relaxed. To my sense of logic, nothing is more linear than a good quality resistor acting as a plate load, compared to another tube sitting on top, making every effort to behave as a constant current source.

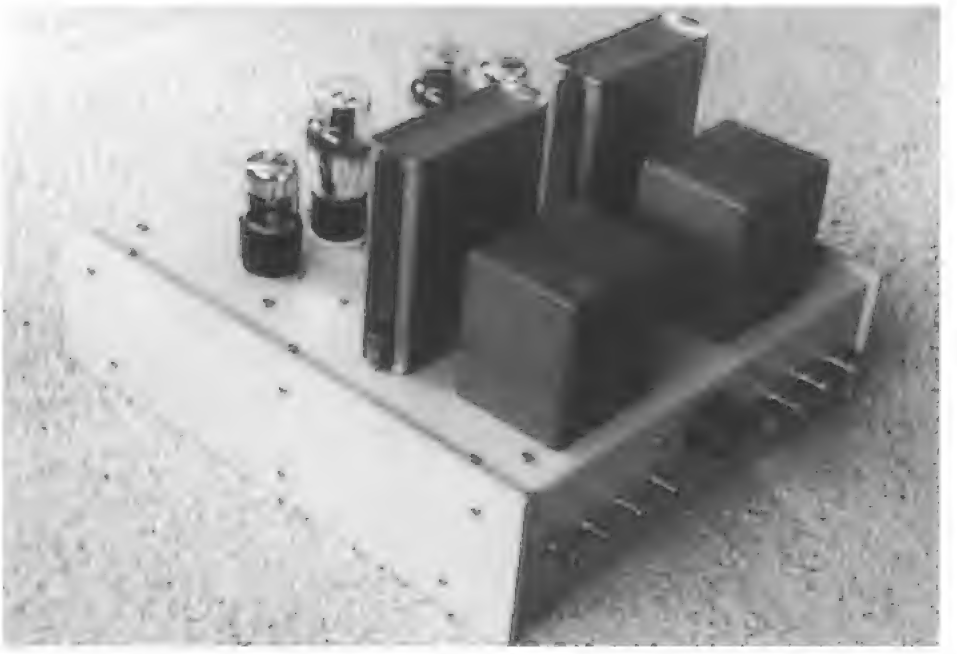
The 76 would be a less than ideal choice without the cathode follower output stage. I like to keep my signal paths as simple as possible, but sometimes too much simplicity can stray from the best possible sound. Tom Weiss did try the 76 as an anode follower driving his amplifier without a cathode follower buffer, and although this tube does boast a reasonably low plate resistance (Rp), he found the sound to be somewhat wooly and lacking in refinement.

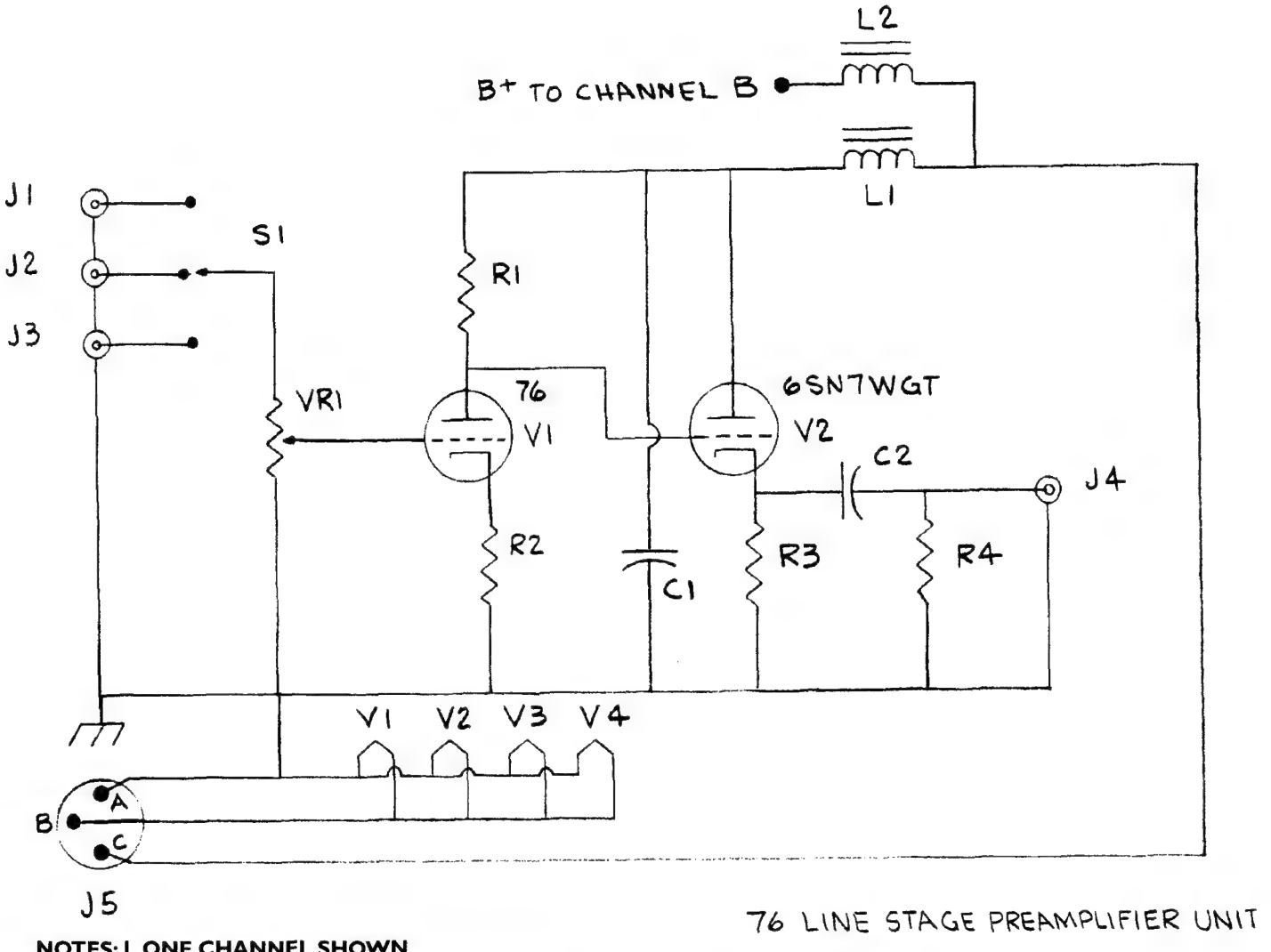
The 6SN7 effectively isolates the 76 from the capacitive interconnect load, and leaves the sound fast and tight. It is biased for 10.5 milliamperes idling current at a plate supply voltage of 400 VDC, which also puts the operating point for this tube well into the linear region of operation.

Note that I only use half of the 6SN7 as a cathode follower in this circuit. Some experimenters will point to their *Radiotron Designers Handbook* and recommend that both halves of this tube should be paralleled to halve the plate resistance, increase the transconductance, and reduce the output impedance.

In theory, I would agree. In practice, when two tubes or tube sections are connected in parallel, the slight fine-grain variations in the transfer function between the tubes will tend to interact, with the effect that the tubes are constantly fighting each other.

The result is a lack of focus and a loss of clarity, definition, and naturalness. Although the use of isolating resistors will tend to minimize this effect to some degree, you will never have the naturalness or refinement achievable with a single amplifying element. Some designers think that it borders on the sacrilegious to have an unused tube section flapping in the breeze, but 6SN7s are readily available and dirt cheap, so I say the heck with it. I want good sound.





NOTES: 1. ONE CHANNEL SHOWN
2. J5 – PIN A: GND; PIN B: 6.3VDC; PIN C:+400 VDC

The Parts Make The System

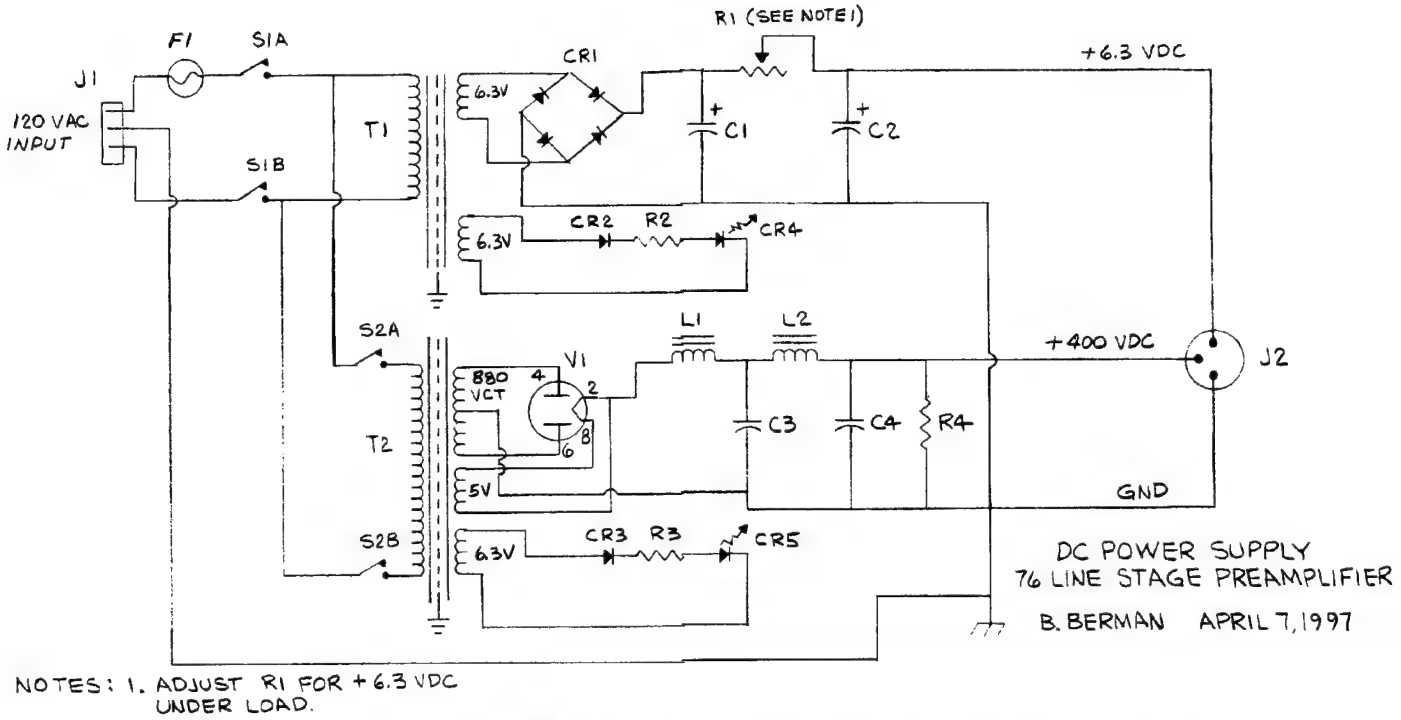
I am a strong proponent of oil and paper capacitors for use as interstage coupling and decoupling purposes. I use these capacitors for interstage coupling in my homebrew single-ended 300B amplifiers, (Audio Note copper foil), and for the capacitive elements in the high and low-pass networks within my speaker crossovers. I also use them for power supply filtering, and decoupling in my phono section, preamplifier line section, and power amplifiers.

For those of you who have never listened to an old stock oil and paper capacitor, they have a smooth, liquid, glare-free sound, completely non-fatiguing, which is in marked contrast to the coarse, unrefined sound exhibited by conventional electrolytics. If you are looking for a natural sound, one that is utterly non-fatiguing, full, weighty, and rich, you must consider the use of old stock oil and paper capacitors in this circuit. I think that if you get lazy and skimp here and use something other than oil and paper for decoupling, you won't know what you're missing. Remember, in any single-ended preamp or power amplifier circuit, the output or decoupling capacitor is directly in the signal return path to ground, so the quality of this part is just as important as the interstage coupling capacitors.

Do not get overzealous and go with large amounts of capacitance for the decoupling capacitors. A small value (i.e. 10 uF. or so), will charge and discharge much faster than a large value capacitor, resulting in fast rise and fall times of the audio signal. Too much energy storage here will slow the sound down, and will result in poor transient response. In addition, 10uF. at this node in this circuit provides a very low impedance return path to ground at the lowest audio frequencies, and a further increase in capacitance will not provide any material improvement in bass slam or weight.

For the output coupling capacitor, I was a bit more open-minded. I am currently using an old, out of production, REL-Cap polystyrene and tin foil capacitor, which in conjunction with the oil and paper capacitors used elsewhere in my system, provides a really nice blend of transparency, speed, and clarity.

The 15 henry chokes in series with the B+ on the preamplifier chassis provide a high order of electrical isolation between channels to minimize crosstalk and maintain high channel-to-channel separation. They also isolate the preamplifier electronics from the power supply and provide an additional section of power supply filtering.



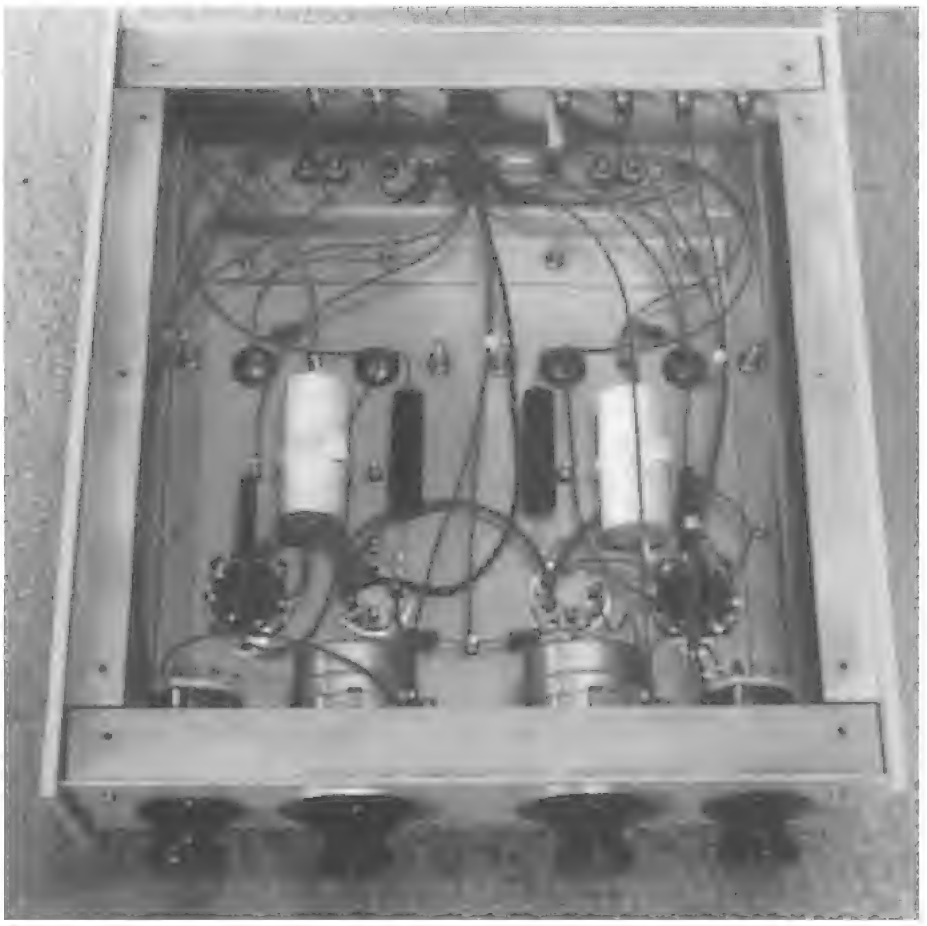
PARTS LIST

C1: 10uF, 600 VDC, oil & paper
C2: 1.0uF, 400 VDC, polystyrene & tin foil
L1, L2: 15hy, 100mA
R1: 33k ohm, 2W, non-inductive wirewound
R2: 1.5 k ohm, 1/2W, tantalum (Shinkoh or equivalent)
R3: 20k ohm, 5W, non-inductive wirewound
R4: 1 meg ohm, 1/2W, tantalum
S1: Ceramic rotary selector switch, silver contacts
VR1: Stepped attenuator, 100k, log. taper Daven Company or equiv. (see text)
J5: MS-style connector (see text)

DC POWER SUPPLY

C1,C2: 30,000 uf., 16VDC
C3,C4: 15 uf., 600 VDC, oil & paper
CR1: Bridge rectifier assy., 100 PIV, 10A
CR2, CR3: IN4003 or equivalent
CR4, CR5: LED, 2Ma.
F1: 1 Amp, Slow-blow
J1: IEC-style power connector, male
J2: MS-style connector (see text)
L1, L2: 12 Hy., 150 Ma.
R1: 3.0 ohm, 25W, wirewound, adjustable
R2, R3: 5.0k ohm, 1/2W
R4: 20k ohm, 50W, wirewound, chassis-mount
T1: 6.3 VAC @ 3A transformer, electrostatically shielded
T2: 880 VCT @ 120 Ma., 5 VAC @ 3A, 6.3 VAC @1A transformer, electrostatically shielded
V1: 5U4G or 5R4GY (see text)





I consider 15 henry chokes mandatory in this circuit because the power supply is unregulated, and therefore it presents a relatively high source impedance to the electronics. The chokes provide a high impedance to the audio on the preamp chassis and in conjunction with the oil and paper decoupling capacitors located within the preamp electronics, keep the audio from finding its way back to the power supply. Any 15 hy., 50 ma. choke with a DCR (DC resistance) of 250 ohms or less will work just fine here.

I have experimented endlessly with both vacuum tube as well as solid state voltage regulators in preamps and I've never liked the electronic sound that these regulators can impart. Series regulators depend on 100% voltage feedback to establish the servo control loop and the deleterious sonic effects of voltage feedback apply here.

Yes, I did try this preamp with a really tricked and optimized 5U4G/6AS7G vacuum tube regulator circuit and the sound became hyper-dynamic, and right in your face, with the usual graininess and coarseness commonly associated with feedback. This "hyper-dynamic" sound may be desirable when driving lifeless amplifiers with lots of negative feedback and speakers of 88 dB sensitivity, but for horn loudspeakers and zero feedback electronics, a natural and relaxed presentation is what we need.

Another element which has a major impact on the sonics of a preamplifier and which is frequently overlooked is the volume control. Avoid the usual ALPS and Noble units seen in most modern high-end gear. My experience has been that they lack definition and impart a certain coarseness and loss of transparency to the sound. I use stepped series potentiometer or L-pad attenuators for the gain controls, to avoid the pitfalls and sonic degradation common to the generic volume controls.

Used rotary attenuators occasionally turn up at electronic flea markets and surplus stores. Probably the most common and well known of these units were manufactured by the Daven Corporation. These controls were the de facto standard for many years for broadcast, recording, film sound and high quality test equipment. They feature silver-to-silver contacts, and precision wirewound resistive elements.They track very accurately and last forever.

I have used the Daven stepped 100K pots for quite some time, and I find them to be really excellent sounding units, so it may well be worth the effort to try to source these devices through the usual surplus channels.

Ladder attenuator kits are available from both Michael Percy Audio and the Sonic Frontiers Parts Connection. Although technically this may offer the ultimate gain control solution due to the limited number of resistive elements in the signal path, these kits use metal film resistors which may not be to everyone's sonic palate.

A bit of audio attenuator trivia; the Daven controls feature a removable rear cover for accessing the contact and wiper assembly. The contacts should have a film of light gray grease or oil on them. This trademark grease or lubricant was called "Davenoil," and was an electrically conductive material which was applied at the factory to ensure smooth mechanical operation, and should never be wiped off.

For resistors, I recommend the use of Mills non-inductive wirewounds in the plate circuit of the 76 voltage amplifier stage and in the 6SN7 cathode follower stage. I like the sound of Allen-Bradley carbon composition resistors in the plate circuit of my power amplifier input and driver stages, but not in a preamp.

The clear, open sound of the Mills' resistors complements the slight softness and sweetness of the carbons later in my system. For the 76 cathode resistor, and 6SN7 1 megohm output terminating resistor, I prefer the sweet sound of the Shinkoh tantalum resistors distributed by Audio Note. I would not condone the use of metal films here, as they can sound a little on the hard side, but many mainstream high-end audio systems may benefit from a little boost.

Grounding in any audio circuit is extremely important, and is a topic which is usually given minimal attention. I always employ the so-called "star-grounding" configuration, in that all components which must return to ground do so only to a single point on the chassis. When fairly complex point-to-point wired circuits are built, this can become somewhat difficult to manage, so I use a solid copper (12 ga.) ground bus, terminated to the chassis at one end only, with all components to be grounded ultimately returning to the bus.

RCA

76

MEDIUM-MU TRIODE

GENERAL DATA

Electrical:

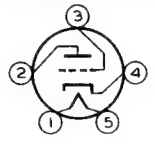
Heater, for Unipotential Cathode:		
Voltage	6.3	ac or dc volts
Current	0.3	amp
Direct Interelectrode Capacitances:[o]		
Grid to Plate	2.8	μμf
Grid to Cathode	3.5	μμf
Plate to Cathode	2.5	μμf

[o] With no external shield.

Mechanical:

Mounting Position	Any
Maximum Overall Length	4-3/16"
Seated Length	3-3/8" ± 3/16"
Maximum Diameter	1-9/16"
Bulb	ST-12
Base	Small-Shell Small 5-Pin
Basing Designation for BOTTOM VIEW	5A

Pin 1 – Heater
Pin 2 – Plate
Pin 3 – Grid
Pin 4 – Cathode
Pin 5 – Heater



AMPLIFIER – Class A_1

Maximum Ratings, *Design-Center Values*:

PLATE VOLTAGE	250 max.	volts
PLATE DISSIPATION	1.4 max.	watts ←
PEAK HEATER-CATHODE VOLTAGE:		←
Heater negative with respect to cathode.	90 max.	volts
Heater positive with respect to cathode.	90 max.	volts

Typical Operation and Characteristics:

Plate Voltage	100	250	volts
Grid Voltage	-5	-13.5	volts
Amplification Factor	13.8	13.8	
Plate Resistance	12000	9500	ohms
Transconductance	1150	1450	μmhos
Plate Current	2.5	5	ma

Maximum Circuit Values:

Grid-Circuit Resistance	1 max. megohm

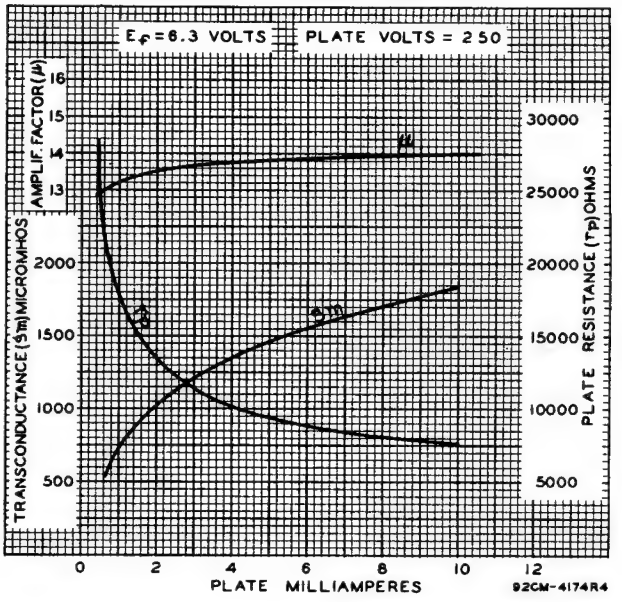
← Indicates a change.

JUNE 15, 1948 TUBE DEPARTMENT DATA
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

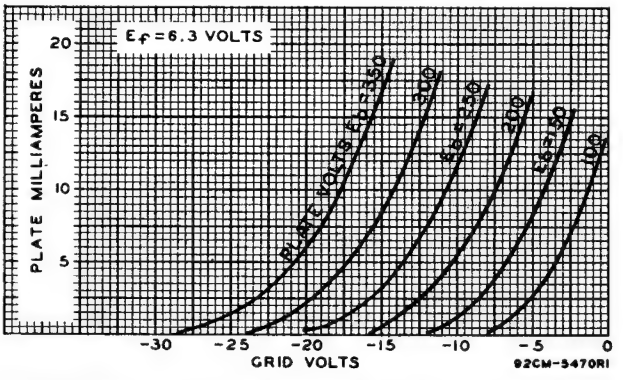
RCA

76

AVERAGE CHARACTERISTICS



AVERAGE CHARACTERISTICS



MAY 19, 1948 TUBE DEPARTMENT 92CM-6983
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

The grounded end of the bus should always be located at a point midway between the audio input jacks on the chassis. The other end can be supported by a ceramic standoff or terminal post to provide mechanical rigidity.

I used aluminum for my chassis; the thoroughly obsessed might wish to use copper or silver sheet for their preamp chassis groundplane. Whatever you use, don't use steel; go with non-magnetic materials.

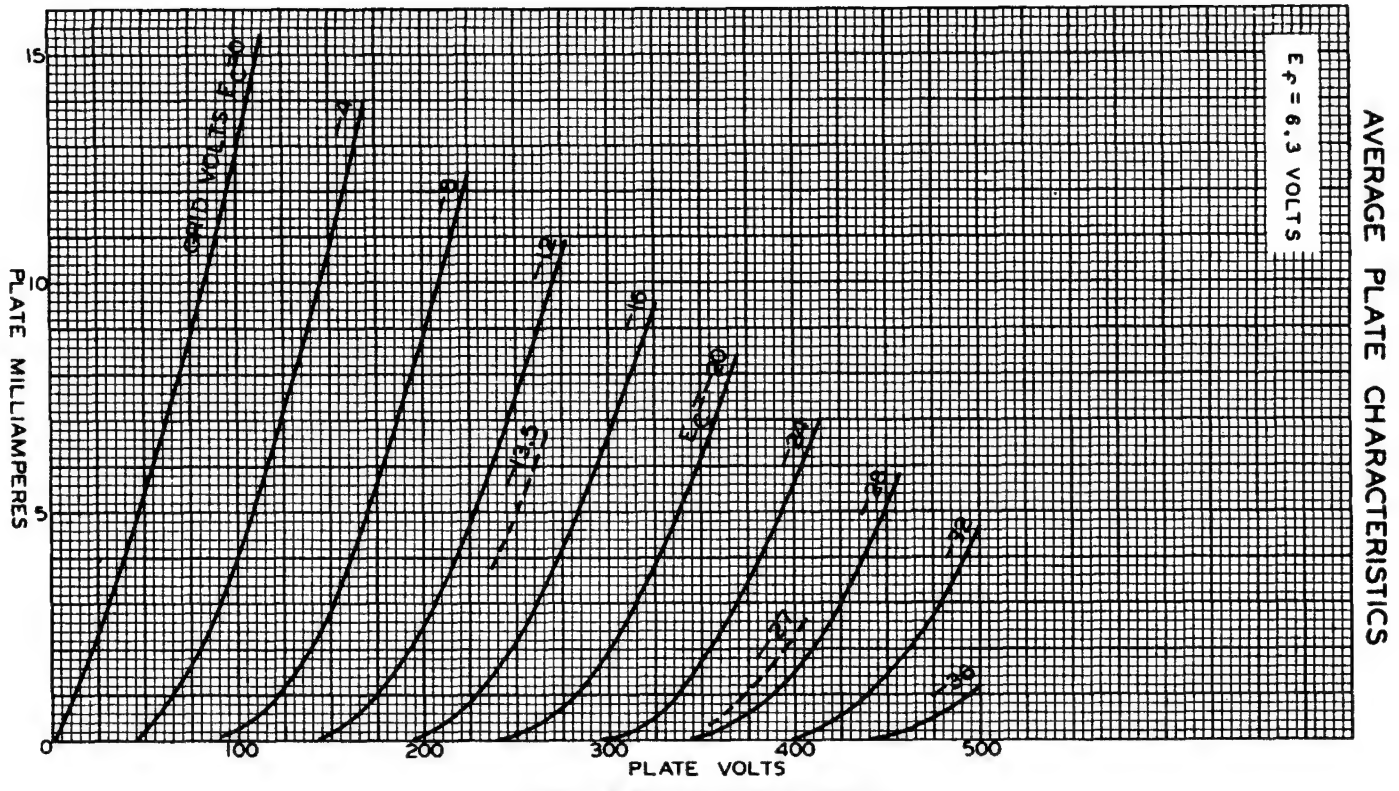
It's The Power Supply, Stupid!

The fact is, any audio amplifier is only as good as it's power supply, as the amplifier's basic function is to linearly modulate the DC provided by the supply. Any noise, ripple, or other artifacts not suppressed by the power supply will find their way into the electronics, with impure, unnatural sound being the end result.

My design philosophy stresses that all power supplies should be mounted separately from the active electronics which they support. This significantly reduces the possibility of any stray 60 Hz. electromagnetic fields, etc., from finding their way into the preamp or power amplifier assemblies. This is an extremist design approach, and although it adds significantly to the size, weight, cost, and complexity of the system, the results are well worth the effort. Another advantage to a separate outboard power supply unit is the ease in making minor or major modifications to the system. How many times have we all been forced to scrap out a piece of equipment because we ran out of real estate to implement a much-desired modification?

Electrically, my unregulated power supply is completely straightforward and quite a traditional design. Using full wave vacuum tube rectification, a two-section choke input filter, and a separate DC supply for the preamplifier tube filaments, it is really just a high-quality implementation of the typical industrial-grade commercial or military-grade power supplies of 40 years ago.

At a nominal line voltage of 120 VAC, the B+ is about 400 VDC. This supply is really overdesigned for this application, since it can support a steady-state load of 120 mA.



Type 76 Plate Characteristics

continuously, and would be ideal for powering up a single 300B in self-bias.

I always use electrostatically shielded power and filament transformers in my equipment. These transformers employ a copper shield, known as an electrostatic or Faraday shield, between the primary and secondary windings to reduce the interwinding capacitance. If you have never used these transformers before in a high resolution audio system, the results can be quite startling, in that the music comes from essentially a black background with none of the veiling or fuzz which we normally take for granted as being an inevitable part of sound reproduction.

The shielding isolates most of the noise on the AC line from reaching the secondary of the transformer, since the shield is connected to ground and this noise is effectively bypassed. Electrostatically shielded transformers can be identified by the schematic diagram screened on the transformer case as a series of lines between the primary and secondary windings, terminating in a "ground" symbol.

I am continually amazed at the number of high-end audio products which do not use these shielded transformers, although most professional audio gear from the 40s, 50s, and 60s consistently utilized them.

In my judgement, vacuum tube rectifiers always provide the purest, most natural sound, free from the buzz, hash, and broadband noise of conventional silicon rectifiers. Diode noise suppression techniques and ultra-fast recovery silicon rectifiers have been described in these pages before, but I can't admit to having much success with them from a sonic standpoint.

My favorite rectifier tube is the 5U4G family for power amplifiers, and the 5R4GY for the preamp line stage, although I use the 5U4G for my phono section as well. 5U4Gs are very rich sounding, with considerable weight and authority in their presentation. The 5R4GY tends to be a little thinner and perhaps more open sounding, a nice blend in conjunction with the 5U4Gs found elsewhere in my system.

I find that these directly heated rectifiers always sound better than the indirectly heated variety, such as the 5AR4, 5V4G, 6X4, etc.; to my ears, these always sound muffled and somewhat rough sounding, and lacking in absolute clarity and naturalness.

I believe that the most overrated and overpriced tube rectifier of them all is the WE 274B, which tends to sound thin and uninvolving in my system. I have yet to try the mercury vapor types such the 83, and these offer the lowest internal impedance of any tube rectifier, which clearly is an intrinsic advantage. Note that they must be used only with choke input filters to ensure maximum reliability and operating life, and they can generate broadband noise if not utilized properly.

The double-section LC filter is mandatory. Do not go with a single section as considerable ripple will be present at the power supply output, and you will plainly hear it. In my system, with 100 dB sensitivity horns and zero feedback electronics, I never have any hum, even with my ear right up to the woofer.

Use chokes with a DCR of no more than 150 ohms each or so, a power transformer of at least 120 ma. continuous current capability, and the total power supply source impedance will not be of any concern. Obviously, chassis real estate permitting, if you have access to magnetics which have even lower DCR, use them, because it is always advantageous to have the lowest possible internal impedance within the supply. Be aware, however, that a point of diminishing returns will be reached quickly, and I'll let you find out where that is.

The separate filament supply allows the filaments to be powered up first, and permits them to come up to operating temperature before throwing on the high voltage, so as

to maximize the operating lifetime of the tubes. All of the power supplies in my system have been configured this way. I could have used a simple timer chip and relay circuit to achieve the same thing, but let's keep any digital noise out of our electronics. Be sure to use an electrostatically shielded transformer for the filament supply as well, as we really want to keep all stray noise present on the AC line from reaching the preamplifier assembly.

Although probably not necessary, I also used a star ground for the power supply. The interconnect harness between the power supply and preamplifier units utilizes Amphenol MS (Military Standard) style connectors at each end for a positive, yet easy to remove physical interface. These connectors feature silver-plated contacts, unbeatable strain reliefs, ease of assembly, superb mil-spec quality, and an incredibly wide variety of possible configurations. These connectors can usually be found at flea markets or surplus shops, but the dumpster diving-challenged can buy these connectors directly from Newark Electronics. Shield the interconnect harness with copper braid, and ground the braid at the preamp assembly-side only.

Since the chokes on the preamplifier chassis effectively isolate the preamplifier from the power supply, little audio is really returned to ground through the power supply capacitors, so there might seem to be little theoretical basis to use premium audio-grade caps here. However, when I breadboarded the power supply with electrolytics, the sound was noticeably worse than with the oil in paper. The SCR film capacitors were much better than the electrolytics I tried, but the best sound to my ears was with the oil caps.

Built Like A Battleship

Much has been written in the mainstream audio press of late about the sonic wonders to be derived from electronics which feature mechanical damping, improved rigidity, and so on. In reality, the equipment should have been designed in this fashion in the first place, without depending upon Shun Mook Pods, Shakti Stones, and other dubious, snake oil gimmicks which offer no valid engineering rationale for their claimed effectiveness. Flimsily constructed electronics sound just that way, and for the best possible sound, we should spare no effort in terms of ensuring that the chassis used for the preamplifier and power supply units are as rigid and robust as we can make them.

I fabricated the preamplifier chassis myself, bending 0.062 inch thick aluminum stock during my lunch hours in the machine shop of the company where I work. I'll never do this ever again, but the resulting metalwork is definitely much better than anything you can buy at the store.

For off-the-shelf chassis, consider those made by Premier Metal Products, of Bronx, N.Y. They offer a line of reasonably well-made standard products which are stamped from 0.062 inch thick aluminum, but be prepared to extensively brace them. I machined some side panels from 0.250 inch thick aluminum, and bolted the entire assembly together using stainless steel machine screws and 3/16 inch thick by 1.0 inch wide 6061-T6 structural aluminum angle stock.

This angle stock is also used to stiffen and brace the top panel of the chassis, and completely eliminates any flexion of this surface as well.

All blind holes, such as those used to attach the bottom cover, utilize interference-fit no. 6/32 PEM-style nuts; I don't use a single sheet metal screw in my entire system. PEM nuts can be installed by any machine shop specializing in sheet metal work. To have 20 or so of these fasteners installed in the power supply and preamplifier chassis for securing the bottom covers should not cost more than $25.00, and is well worth the cost. Drill out the through holes in the bottom cover panels first, bring everything to your favorite machine shop, and they will transfer-drill the correct sized holes and press the PEMs into your chassis.

I don't recommend the standard-issue chassis bottom covers offered by Premier, Bud, etc., as these are usually fairly flimsy; have the machine shop shear you a 0.125 inch thick piece of aluminum for this.

Before the chassis are painted, they are given a gold irridite chemical film treatment. Irriditing is a simple and inexpensive process which renders aluminum impervious to oxididation while at the same time maintaining an electrically conductive surface which is low in resistivity. It also provides an ideal bonding interface between paint and aluminum. It should not cost more than $25.00 to have two chassis and two bottom panels irridited. Irriditing can generally be sourced through the telephone directory, under "Metal Finishing".

In contrast to most commercially manufactured high-end audio equipment, I strongly believe that all individual mating metallic chassis components should be assembled so that they are free of paint, etc. We are looking for a chassis that will not only serve as a robust structural framework for our electronic creations, but one which will provide effective electrical shielding as well.

Since there is no accounting for taste, I'll leave the industrial design aspects up to you. Some homebrewers prefer a more modern grained black or champagne-gold anodized finish, whereas I prefer the 1950's gray hardcore industrial look.

The Sound of The Tubes

I have listened to 76s made by RCA, Sylvania, Tung-Sol, and Philco. In my system and to my ears, they all sound very similar. Considering the incestuous nature of the vacuum tube manufacturing business, perhaps all of these different brands were really built by only one company and private labeled for everyone else. You can safely use any of the aforementioned brands in this circuit.

Note that some 76s can be microphonic, so beware. I am using 1943 production RCA JAN 76s in my preamp, and I have never had any problems with microphonics, but you may have to screen a few tubes to get quiet ones.

The 6SN7 is an entirely different story. First off, the 6SN7 cathode follower in this circuit uses 100% current feedback to improve the linearity of this stage, and my belief set led me to think that cathode followers have no real sound of their own, but was I seriously mistaken on this assumption. The choice of 6SN7 will have a significant effect on the voicing of this preamp.

I tried RCAs, Sylvania JAN and commercial-grade versions, GEs, Raytheons, CBS Hytrons, and red base RCA 5692s. In my system, the obvious winner was the Sylvania brown-based JAN 6SN7WGT with either the green or gold lettering. Fast and clear, with an open, detailed and natural sound, it is the obvious choice to drive the side-getter GE 6SN7GTB input/driver stage I like in my power amplifiers. The Sylvanias sound very different from the warmer, somewhat slower sounding GEs, and the two tubes really complement each other in my system.

The other 6SN7s auditioned were strictly second-rate, and unworthy of serious consideration. Most disappointing is the highly touted and expensive RCA 5692. Classy looking, to be sure, but no real contest with the Sylvania 6SN7WGT and GE GTB.

Interestingly, the commercial version (6SN7GTA/B) of the Sylvania JAN tube is distinctly inferior in sound, and I have no

plausible explanation for this. Tung-Sol made a round-plate JAN 6SN7 with a VT nomenclature, probably using 6SL7 tooling, which is fabled to be really great sounding, but I have never heard these. Forget about the Russian and Chinese versions which are currently available since the great NOS tubes are still so easy to get.

For the power supply, use any U.S.-made 5U4G, GA, or GB; or for an airier, more open sound, try the 5R4GY, GYA, or GYB versions. Whatever you do, experiment with different tubes until you arrive at the combination which most suits your listening tastes.

As discussed earlier, this line stage preamplifier will not be to everyone's liking. Perhaps listeners of conventional off-the-shelf high-end systems with inefficient direct radiating speakers and so forth using this unit may possibly find the sound to be somewhat slow and uninvolving, due to the sound of the oil and paper capacitors and other reasons elaborated on earlier.

I tried to design and construct a unit that aspires to my sonic ideals, aesthetics, and system-building style. I believe that this line amplifier would fit most comfortably in systems utilizing directly-heated single-ended or push-pull triode amplifiers with no global feedback, driving horn-loaded loudspeakers.

But, then again, I could be mistaken about this. Many of the strongly-held assumptions and beliefs I had about system matching and audio engineering in general have been seriously challenged of late, and this could well be another example!



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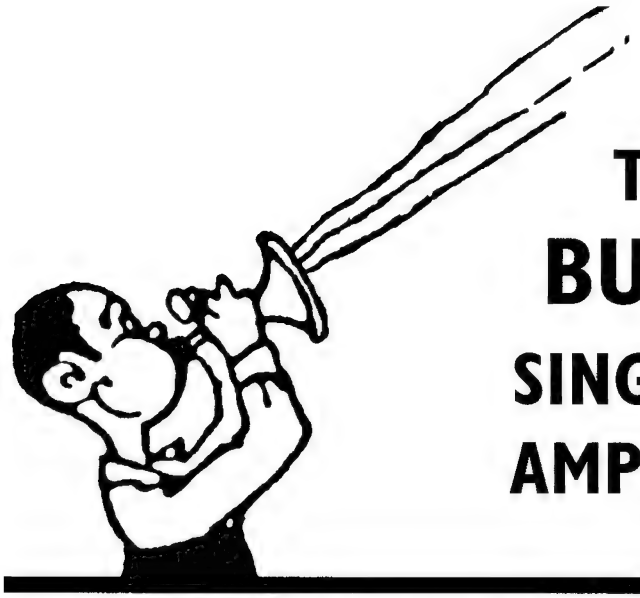
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THE BUGLE SINGLE 45 AMPLIFIER

by Gordon Rankin, Wavelength Audio

The chief scientist at Wavelength throws the DIYers another bone...

For some time now I have been building obscure amplifiers under the names of some of the better brass instruments. The *Trumpet* was my original name for the *Baby Ongaku* from *SP #9*, the *Flugelhorn* is an interstage coupled parallel 45 amplifier and the *Trombone* is a cool 300B circuit. All of these designs are less than apt for today's market because of one attribute or another—unavailable tubes, "weird" idea, not enough power for the US (bull-headed) market.

Today we are going to analyze my favorite from this collection, the *Bugle*. The *Bugle* is a stereo 45 amplifier yielding a generous 2.5W of power. I don't even try to sell this amp anymore because of time and sketchy availability of the 45 tube, but sound-wise this amp would be a good investment for the DIY hobbyist. It is designed to be a simple, high performance circuit that also would be simple to build.

One nice thing is that a 45 is always a single plate tube and a lot easier and cheaper to find than the single plate 2A3. Also, there are rumblings that the Chinese are remaking the 45 tube, but I haven't seen any yet myself!

When designing an amplifier, I always start by characterizing the speakers and work my way back. I would estimate a good speaker of 95dB sensitivity or better at 8 ohms or higher to be right for this project.

So, let's pick the super-sounding 45 tube, which has a dissipation of 10W on the plate. In my experience the 45 is best with no more than 35mA plate current. We can take the plate voltage up to 275V at that point. I believe that when using the 45 (as well as other directly heated triodes) that self bias is best. The required bias at 275V for 35 mA plate current is -55V (actually, based on the dozens of 45s I have tested, you can expect between 52-54V in real life), which when added to the 275V plate voltage makes for a total B+requirement of 330V.

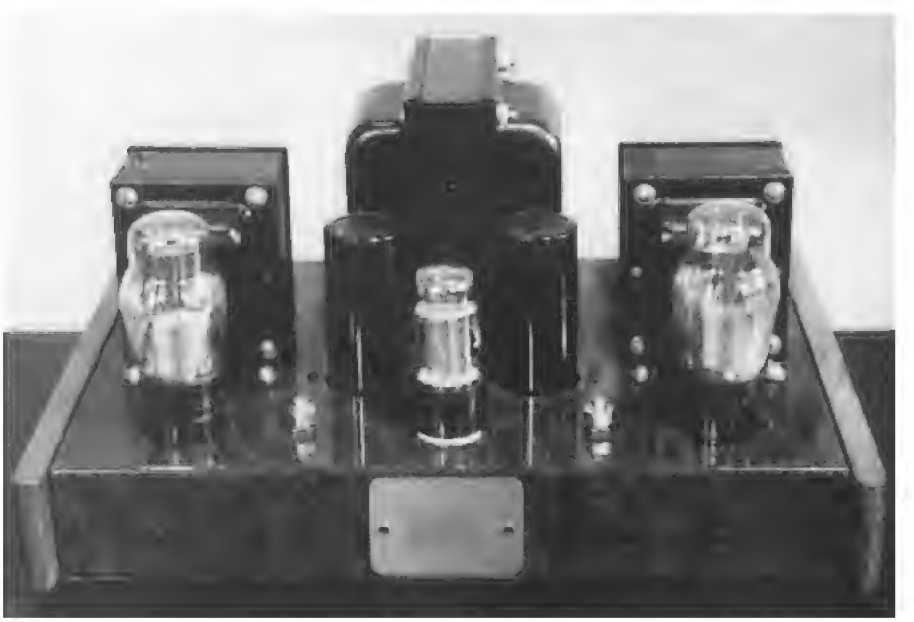
From here, we can calculate the rest of the output stage by selecting the output transformer and the biasing resistor. The plate impedance for a 45 running at 35mA is 1700 ohms. For the best results when using triodes, the transformer primary impedance should at be at least three times the plate impedance of the tube. Since there are no 5.1K primaries in stock, we can easily make do with a 5K primary transformer with a rating of about 35 mA or more.

The bias voltage is between 52-54V volts so, by Ohm's Law, we divide the mean voltage by 35mA and get a bias resistor of 1514 ohms or better yet use a readily available 1.5K unit.

We can determine the wattage dissipated of this resistor by I squared x R = 1.8375W. I try to de-rate all my wattages by a factor of 5 for long life and stability. In this application, I would use at least a 10W rated part. In my version, I used the 12W Mills MRB-12 resistor because they are really nice units at that wattage.

We can see from Sidebar A that the bypass capacitor we need is at least 22uF. A SCR AEON 24uF/250V would work fine.

For the drive stage, we see from Sidebar B that we need a slew rate drive current of 1.1ma or better. Actually we reach the maximum output well before the bias



The Wavelength Audio Bugle Stereo 45 SE – great amp but not a big seller among the power-crazy mainstream market at 2.5 Watts per side!

voltage of -55V, but it is better to have a higher slew rate current for better transient performance.

To get the most out of an input stage I try to set it up so that with a 1V input to the amplifier, I get the maximum output. I then bias the gain stage so that the bias voltage is a factor of 1.5 to 2 times the 1V input (i.e., -1.5V to -2V of biasing). This is done so that the input stage does not clip before the output does.

In the *Bugle*, I originally set everything up for the 6072A, one of my favorite tubes. Then I also found that with the same biasing resistors, the 5751 also worked and provided a higher overall gain. I biased the 6072A at 2V @ 2mA at about 140V per plate in SRPP mode. The bias resistors for each section work out to be 1K.

You can use Sidebar A again to determine the bypass of the lower R in the SRPP. I use the Black Gate BGN 33uF/16V for the job.

I find the SRPP drive stage to be good sounding, and easy to implement,offering a lot better output capacity than plate loading the same tubes. Because there is enough local feedback in an SRPP so that it is not beating the tube for maximum gain, I find it vastly superior in sound to all the types of the mu follower designs. Following this logic, a simple plate loaded tube should sound best, and maybe it does, but then you have to use two stages and that introduces another set of problems. In my experience, the SRPP is the best sounding simple way to go.

At 2mA, the 6072A has plenty of slew rate current. This design has an output impedance of about 15K. The 45 has a maximum grid resistance of 1M in self bias mode. If we use a resistance of 470K (I found some of the globe 45s draw grid current when a higher value is used) we can determine the necessary coupling capacitor.

I found that the best plan for bypassing is to use 5Hz as the limiting low end for calculations. Most designers go way overboard with the bypass capacitance, slowing things down. So we have 1/(2*PI*F*R) = 1/(2*PI*5*470K) = 0.0677uF. I use a 0.047uF for a low end response of 7.2Hz, plenty for this type of amplifier.

Also, the smaller the capacitor the better the sound. Lately the largest coupling capacitor that I can stand is a 0.25uF in an amplifier. I would try the Audio Note copper or silver foil or the Hovland *MusiCaps*. Since there is a potential of 140V across the capacitor, a 400V or higher voltage rating is required.

Okay, so we have the gain, output stage, now we need the power supply. The 45 requires a 2.5V filament at 1.5A, 6072A needs 6.3V/0.3A each, and we need a supply B+ voltage of 330V.

I prefer a choke loaded power supply over a Pi filter because the bass is so much faster and punchier with choke input. For this design I would use the 5AR4/GZ34 rectifier because of the low B+. If you are building an amplifier with a higher B+ voltage, then you may have to use its bigger brother the GZ37. To determine the transformer necessary for the desired B+ output using the curves supplied by Amperex we see that we need a plate to plate voltage of 700-720 for the full dissipation of some 80mA (stereo circuit).

What I do to trim the voltage is to add the input capacitor Cx to get the B+ up to where I want it. The reason the circuit does not come in at the exact voltage shown in the curves is because of the resistance in the choke and losses in the power transformer. A small input cap can be used with a choke input to raise the output voltage to make up for these losses.

With the transformers and chokes I used, the correct value of Cx is 0.68uF. This cap should have a DC voltage rating of 630V or better. Some would say this is a Pi filter but because of the small amount of capacitance after the rectifier this is not really the case. It actually acts very much like a choke input. Refer to Chapter 30 in *Radiotron Designers Handbook*, 4th ed. for details on power supply calculations.[Or look up the power supply chapter in "The Radio Amateur's Handbook," published annually by *The American Radio Relay League* since the dark ages—*ed.*]

SIDEBAR A—
Determining bypass capacitor values

We know that the gain when the bypass is fully functional is mu*R1/(R1*Rp). We also know that with a unbypassed resistor R2, the gain is mu*(1/((Rp +mu*R2)/R1)).

Capacitance has a reactance at any frequency which is given by 1/(2πf).

From these three equations we can determine the bypass capacitance in the following steps:

1) Find the total gain of the circuit.

2) To find the bypass C at a desired -3-dB point, use algebra from gain equ #2:

R2=((mu/gain -1)*R1 -Rp)/mu

R2 is actually the resultant R at frequency f of the C in parallel with Rbias.

3) Then we find the phasor resistance of C from 1/R2 = 1/Zc + 1/Rbias

4) Knowing Zc we calculate C = 1/(2πf*Zc)

Example for the output stage of the Bugle

1) 5000*3.8/(5000+1700) = 2.836

2) -3dB at 5Hz makes the gain at 5 Hz equal to 0.707*2.836 = 2

3) ((3.8/2 - 1)*5000 -1700)/3.8 = 730.7 ohms

4) 1500 ohms in parallel with 730.7 yields a Zc = 1424.739

5) At 5Hz then C= 1/(2*PI*5*1424.739) = 22.34uF close enough to 22uF.

SIDEBAR B—Slew Rate Calculation

Knowing the bandwidth, input voltage and the two input capacitances of the tube, we can determine the necessary slew rate drive current to overcome the input capacitance of the stage.

1) Slew Rate = 2*PI*BANDWIDTH*Vin

2) Per Borbley and others, to fully overcome the input capacitances, multiply #1 by a factor of 5 in slew rate current calculation #4 below.

3) Determine the combined input capacitance as

Ct = (Gain +1)*Cgrid-plate (Cgp) + Cinput (Cinput is sometimes referred to as Grid to Cathode or Cgk).

Plug in the actual gain achieved in the circuit, not the mu of the tube.

4) I (slew rate current) = Ct*5*Slew Rate.

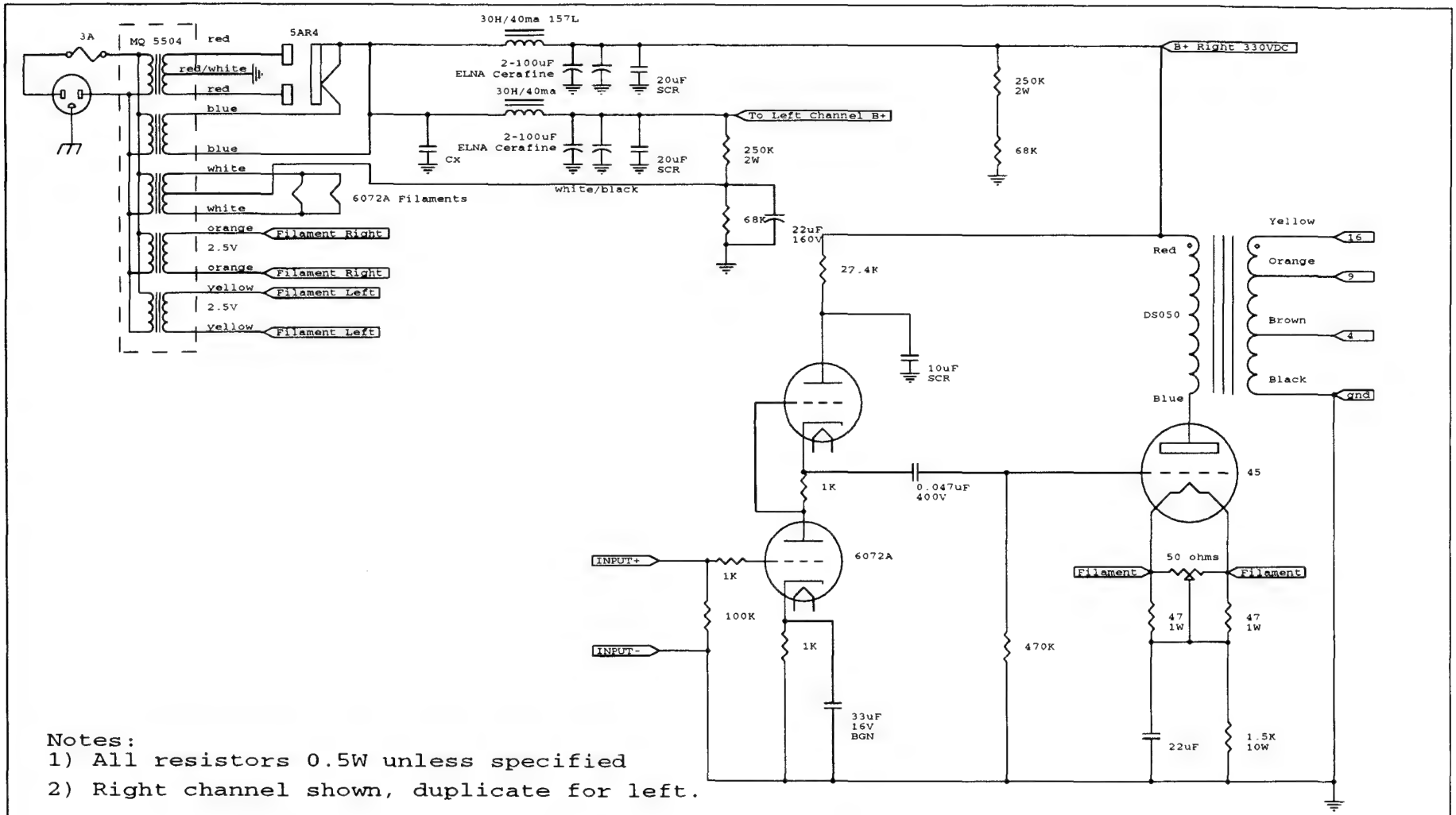
Example for the Type 45 power triode:

1) 2*PI*20Khz*55V = 6,911,503 referred to V/uS works out to be 6.9V/uS

2) 5*6.9V/uS = 34.55V/uS

3) Ct = 7pF*(2.836 +1) + 4pF = 30.8pF

4) I = 30.8pF*34.55V/uS = 1.066ma



Notes:
1) All resistors 0.5W unless specified
2) Right channel shown, duplicate for left.

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Title	Bugle 2.5W Stereo Amplifier	
Size: B	Document Number: HORN-B-C	REV: C
Date: May 1, 1997	Sheet 1 of 1	

I have found large chokes and smaller capacitors to be the best case for choke loaded supplies, but high capacitance or multiple stage supplies are necessary for low ripple on the supply. Here we will use 2-100uF in parallel with a 20uF SCR film for a high-C, single-section supply. That will drop the ripple down to less than 30 mV p-p with a 30H Hammond 157G choke for each channel.

Since we have a B+ of 330V we need to drop this voltage for the 6072A by around 55V @ 2ma, requiring a resistor equal to 27.5K ohms. A 27.4K with a wattage of 0.5W or better should do the trick.

Also since the upper cathode of the 6072A (or 5751) will be at 140V+ volts, we want to put a positive voltage on the heaters relative to ground so that the cathodes do not exceed the rating for cathode to heater voltage (90V for both types). If we use around 70V, both cathodes will be in good shape. A voltage divider consisting of 250K & 68.1K resistors across the B+ provides the needed 70V bias.

That's it for design, now some parts notes:

I use Shinko tantalums for all my 0.5W and 1W needs these are available from *Angela Instruments* (301)725-0451. The Mills and most of the capacitors are available from *Michael Percy* (415)669-7181. The chokes are available from *Handmade* (610) 432-5732. The chassis are available from *Experiences Sonores* (418)652-8788 FAX—see ad in *SP #12* page 50, right picture is the *Bugle* chassis. The output and power transformers are from my faves *MagneQuest* (what's that number...) (215) 288-4816.

I present this work in the spirit of DIY for the personal, non-commercial, hobby use of SP readers *only*. I must restrict copying of this schematic, without written permission from *Sound Practices* and *Wavelength Audio*. Also, please do not call me and ask me what color to paint the amplifier. I can respond to *e-mail questions only* at: waudio@cinti.net. No calls please! Somebody's got to work around here!

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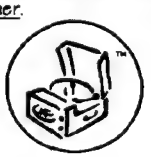
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DISTORTION MINIMA LOADING of the SRPP

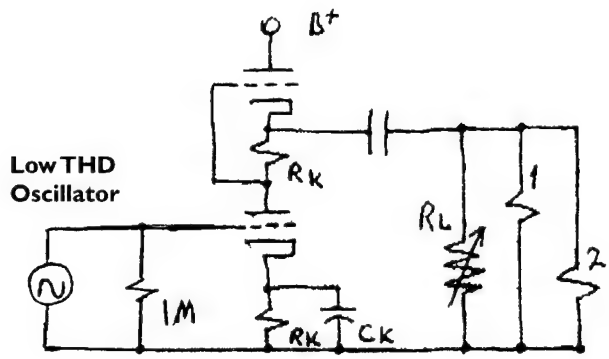
by
Mike Vans Evers,
The Vans Evers Co.

The series-regulated push-pull (SRPP) circuit has an interesting quirk that bears illumination. Decreasing the value of the load resistor on a normal active stage, tube or otherwise, usually causes distortion to go up, and maximum Vout for a given distortion level to go down. Not so with the SRPP. There is a dip in the distortion/load curve (see graph) that cuts distortion at least in half. Of the more than three dozen tubes that I tested, only a few failed to exhibit this characteristic dip. The value of load resistor is different for each type and brand of tube. At this point in time, there is no cookbook formula, so a THD analyser is necessary for determining this value.

It seemed apropos to call this technique Distortion-Minima Loading (DML). Looking at the DML benefit another way, an SRPP loaded properly will have a higher output swing for any given level of %THD (see table 1).

This quirk has side benefits that can be exploited in minimalist line-level preamps. Voltage gain circuits amplify more than just the signal. They also amplify internal and externally generated noise. High gain circuits generally have more noise at the output of the preamp than do low gain circuits. Because these circuits are commonly connected after the volume control and thus directly to the output of the preamp, all the self-noise becomes part of the signal. This amplified noise can become a significant portion of low-level signals, causing low-level detail and three-dimensionality to suffer.

The benefit of a low-gain line stage is that for a given output level, there is less noise mixed in with the signal. The DML technique reduces distortion AND gain, without the need for loop negative feedback. For example, a 12AU7 SRPP using the DML technique has a gain of about 10 dB, which is more than plenty for most line amplifier applications.



1- 5 Megohm VTVM

2- 100k Input Impedance of distortion analyser

Rk = 787R
Ck = 47mF
B+=300 V
Oscillator at 2kHz

SRPP DML Test Set-Up

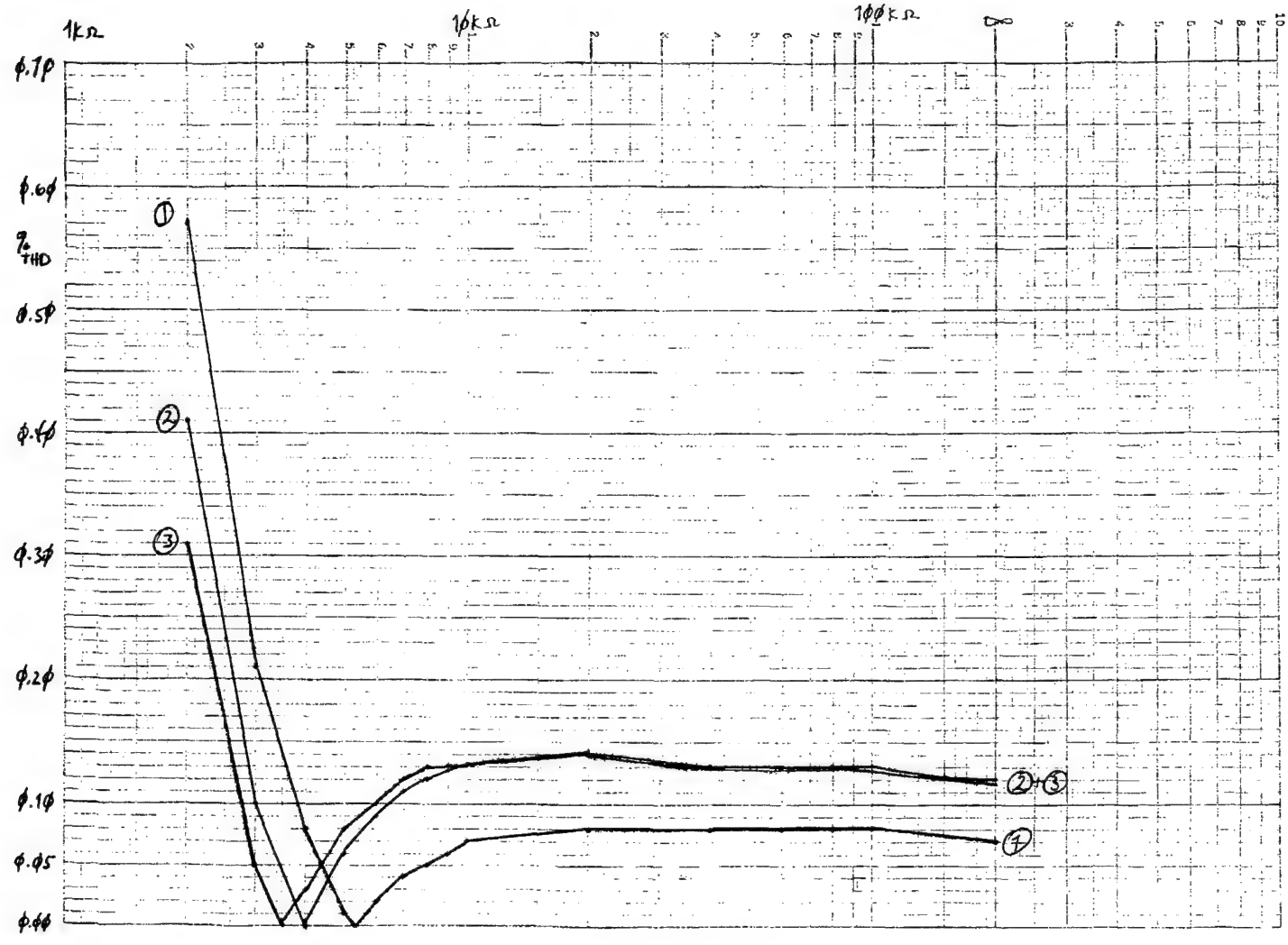
Table 1

R_L (Ω)	DML=Actual Load RL/5MΩ/100kΩ	Ck (μF)	V_{RMS} Output for 1% THD 7119 #1	5687 #1
20k	16.6k	0	24.1	22.5
20k	16.6k	47	12.1	12.3
10k	9.98k	0	35.6	26.7
10k	9.98k	47	11.5	11.3
7k	6.99k	0	44.8(0.45%)*	
5k	6.99k	0		34.3(0.7%)*

* Insufficient Osc. Vout for 1% THD

Table 2

Tube	Max.Vout @ 1%THD (unless other % given)	DML Ω	Frequency Response @ 20 kHz @ DML	R_L=98k
7119 #4	44.2 (0.37%THD)	6.18k	-0.04	-0.06
RCA 5965	50.2	22.2k	-0.36	-0.54
Brand X 12AX7A	28.4 (Rk=1.24k)	16.4k	-0.59	-1.36
Brand Z 12AX7A	20.3	28.9k	-1.66	-2.44
National 12AT7	27.2 (Rk=1.24k)	11.2k	-0.30	-0.87
Sylvania 6DJ8	34.3 (B+=240V)	6.71k	-0.06	-0.11
Syl-ECG 6CG7	19.5	3.66	-0.01	-0.23
GE 6BL7	14.2 (Rk=255R)	794R	0.00	-0.07
Tung-Sol 6BX7	12.4 (Rk=255R) (0.53% THD)	576R	-0.02	-0.04



Vout= 2.0 VRMS
100K analyser Rin not included in graph figures

1— Gold Dragon 6DJ8
2— Amperex BB 6DJ8
3— Telefunken E88CC

Rk=787R
B+=240V

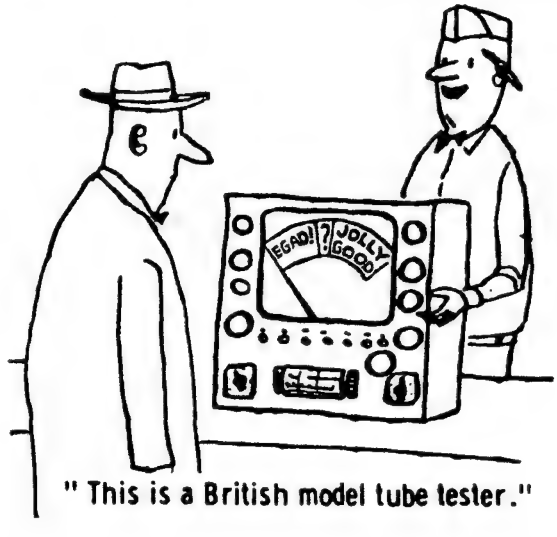
Typical behavior of triode SRPP voltage amplifier illustrating effects of Distortion Minima Loading

Other applications include drivers for EQ circuits, long interconnects, and power amp output tubes. A 7119 DML-SRPP with only 300V B+ can swing 125 volts peak-to-peak with less than 0.5% THD (Tubesox and Pearl iso-sockets recommended to combat microphonics).

There are a couple of questions that would make life easier if they could be answered:

1. How does tube aging affect the DML value?

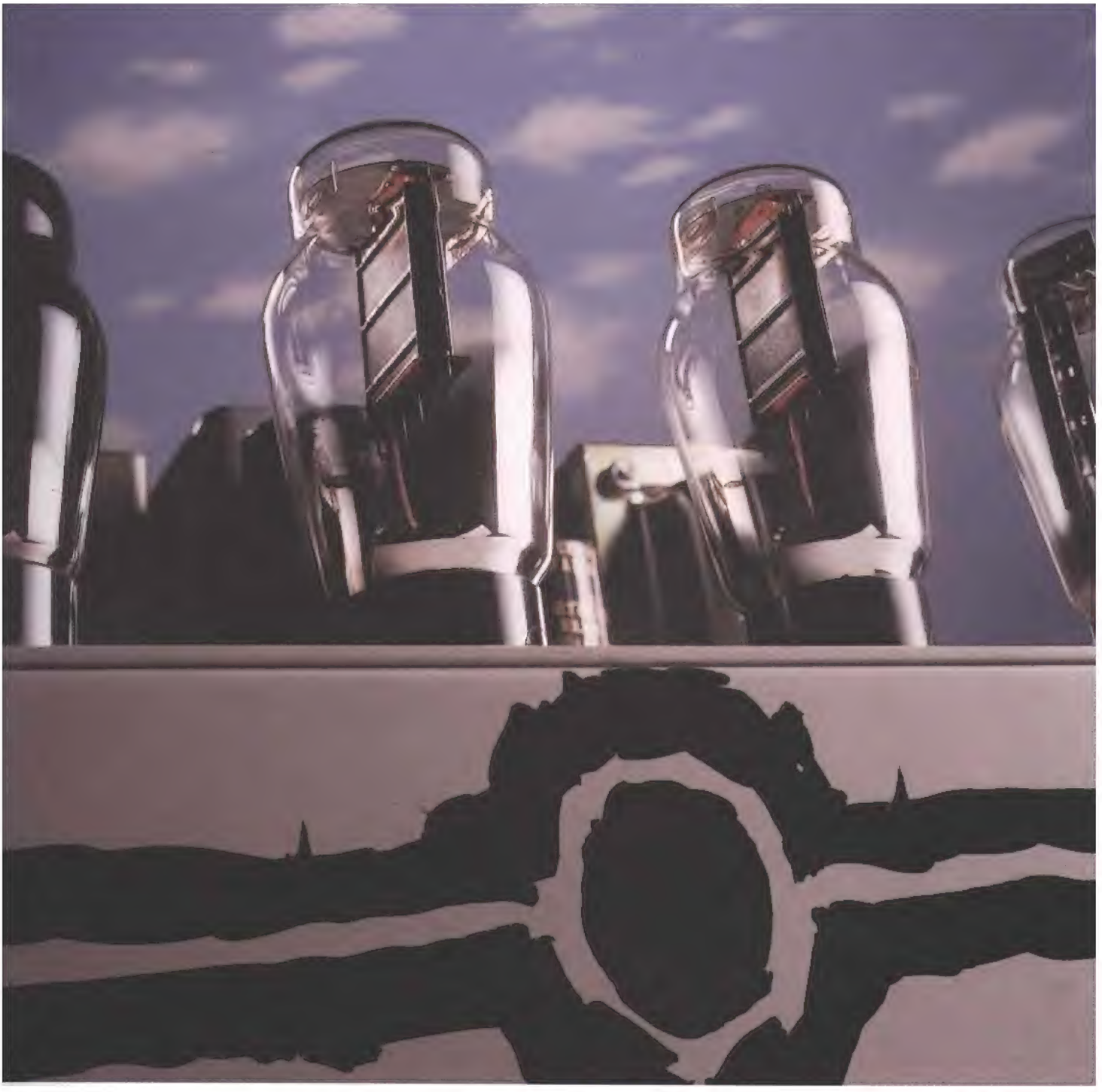
2. How can the DML value be determined mathematically? (Hint: the DML value usually changes in proportion to the value of the cathode resistor; if Rk goes down, so does the DML value).



" This is a British model tube tester."

SOUND PRACTICES

THE JOURNAL FOR AUDIO EXPERIMENTERS FIVE DOLLARS



Innocence and Experience Issue 14



I'd like to begin with a minor confession: I am a cynical bastard. Its a full time job, let me assure you. The extra work comes about because of the effort required to navigate around the most fundamental suspicion: that humans fu*k everything up, especially the remarkable. Now, I have not simply jumped to some arbitrary conclusion here! And it is not only because of my tiny mind, just a natural order of things in a human world dominated by fear, ignorance, and heavy competition. Who can actually afford to deeply care about anything extra right now, other than James Watt's big three important necessities? Some of us, perhaps, are actually forced by circumstance to place the pursuit of "Pampers" or similar other goods and accessories, ahead of a beautiful ethical life...

Whatever the root causes might be, the result is the same. Just as you are becoming aware of the mysterious and terrible beauty of the universe, some Joe-neckbone is going to throw his leftover Bob's Bigboy out the window of his rapidly moving Camaro in such a way that the most spectacular light you have ever seen in August is permanently darkened. So when something magnificent comes along, whether or not it has anything at all to do with making the rent, or binging and purging, it takes work, at least on my part, to make sure I am present for it. And I do generally try, because that kind of experience is precious, utterly valuable.

In light of this, I would like to suggest that the audio recording medium is an amazing thing. It is possible to bring home, right now, from both the Sistine Chapel and any one of its many charming present day counterparts in Los Angeles, the ghostly echoes of the two great castrati of our century: Allesandro Moreschi and Michael Jackson. The immense distance between the two contexts, the 1902 passing of a strange and decadent tendency of "classical" European culture and the equally complex pop construction that has replaced it, doesn't present any obvious difficulty for us "listeners" today. Most of us just don't care about why or what these traditions mean in any original sense, we just use the music for our own base motives. We use it to eat to, to seduce our lovers, we collect it as objects, as a soothing emotional wallpaper, or to make us seem sophisticated or fun-loving to those we hope to impress, maybe even dance to, blah, urp, etc....

Delivered under the proper circumstances, however, many of us are still able to find something remarkable, perhaps a spiritual thread, in recorded music that can occasionally lift us above the pressures of ordinary existence. Just don't assume I mean to use "spiritual" in a religious sense at all. Charles Manson's ego deflating "I am we and we am I" is close enough. That or, "the things that make you go hmmmm... (reprise)".

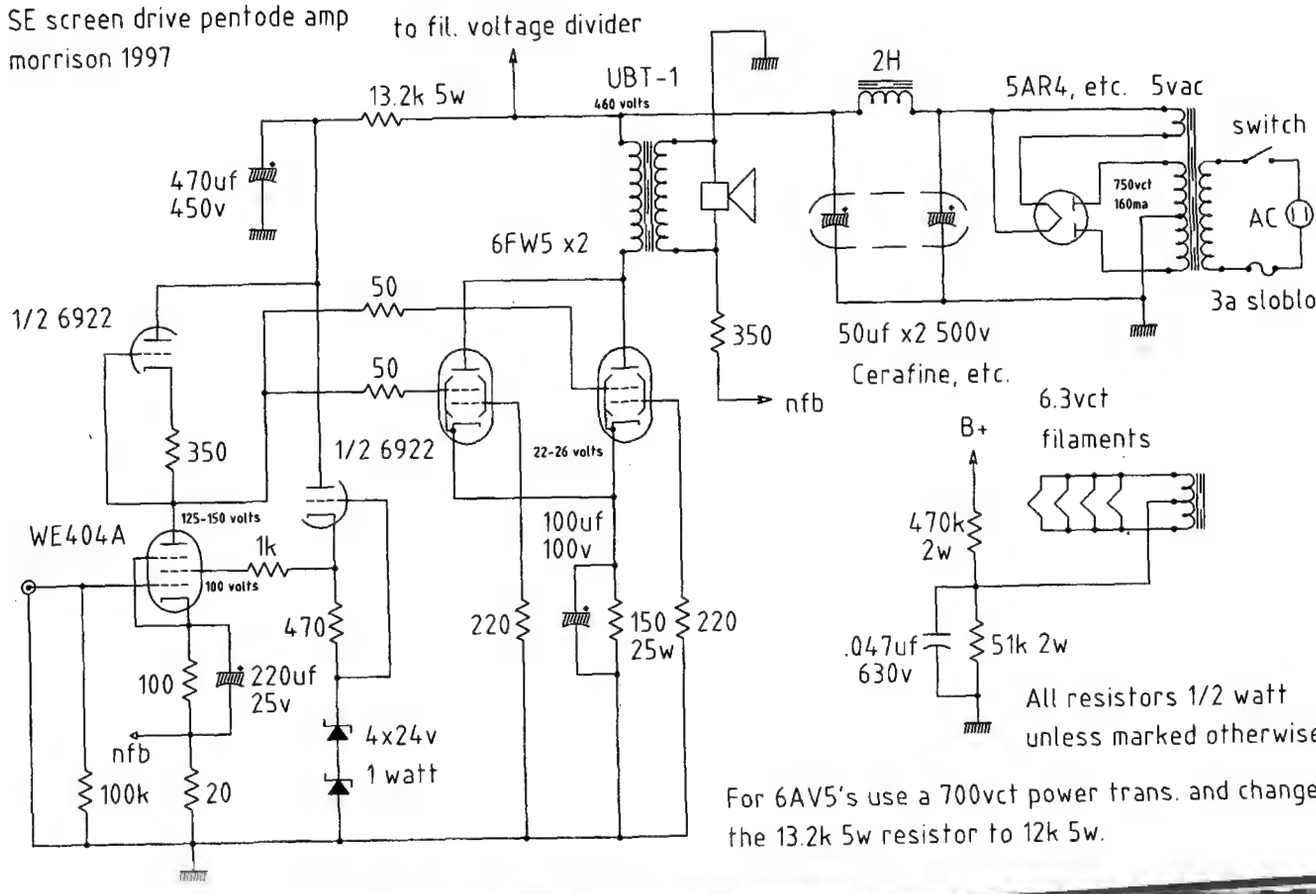
As a side-note, it is still surprising, even for a jaded punk such as myself, that actual contact with a musician has fallen so out of favor, in comparison with the more easily handled electronic surrogate. That extra "whatever" that differentiates musical magnificence from normal routine is apparently more easily consumed at home. But, the topic for today is the amazing EP/LP/CD/tape/DAT/Minidisk/Laserdisk/8-track(!). What the hell is it really?

Recorded music is fundamentally different from live music. The core difference, as I see it, is its virtual nature. Music has done gone vaporized! The very word "music" no longer means "that which is performed by a musician", actually most people think immediately of a compact disk. It is no longer necessary to dress up for the opera or have a duchess aunt to get down with the male sopranos. In fact, there is no need to know anything or anyone to immerse yourself in the sacred music of the tribes, violin or accordion virtuosos. You can even splice it into your own funky slice (I do love the Beastie Boys...) with a minimum of musical know-how, equipment and taste. We can, in fact, beam down to any salable musical ethic or tradition at will. The only thing one actually needs is a spare $16.99.

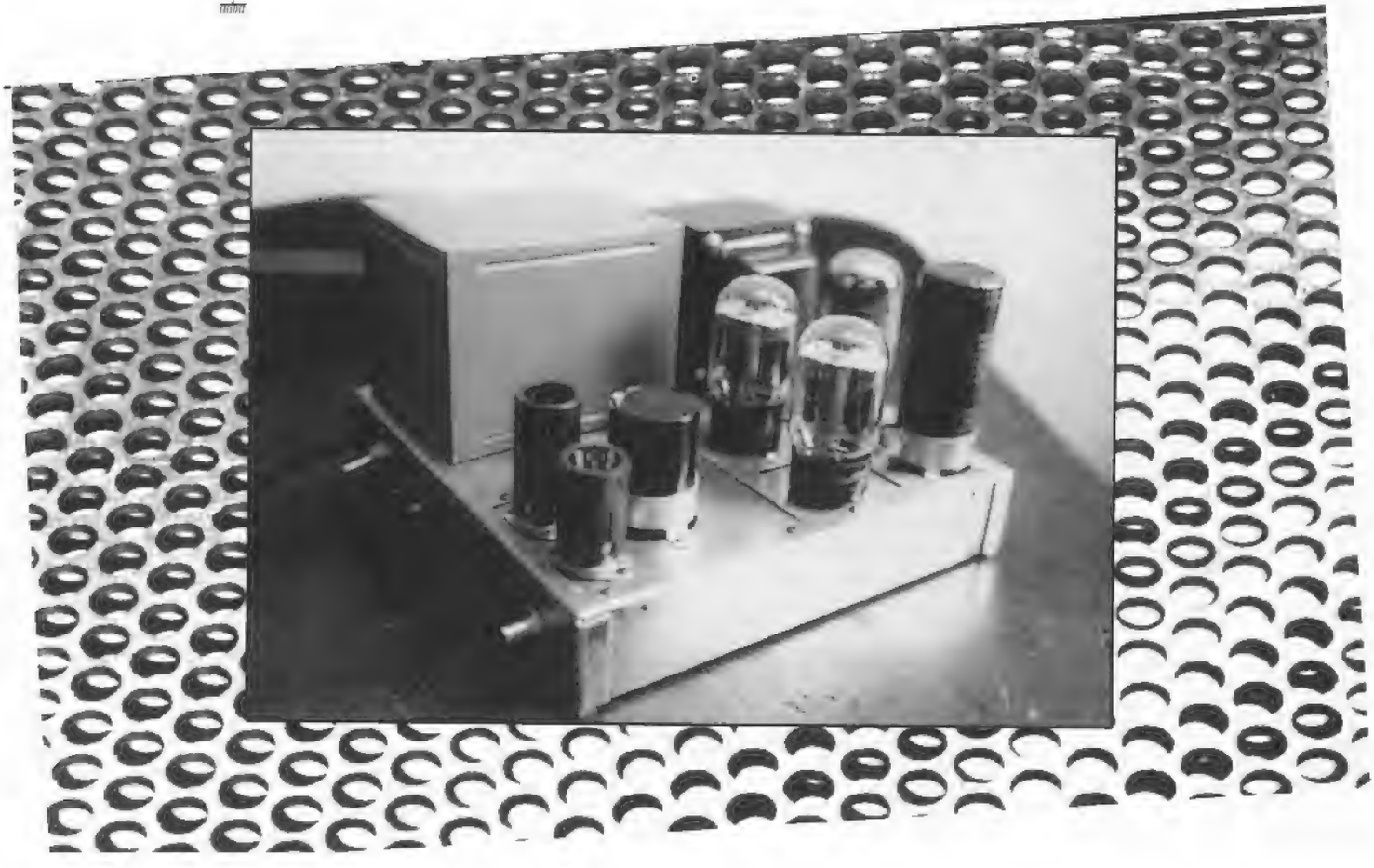
This virtuality has obviously changed the way we use music, but it has also changed the way we judge it, make it, market it, buy it, and HEAR it. The problem is that the hardware/software we rely upon for "playback" and the context in which it is employed today underlines the experience with such complete transparency, most people have forgotten that it's there.

As I mentioned above, for most people, the "ware" IS music now. But, there's a lot more! The "space" of the recording is no longer any place, it is all places and any time. Name your destination!

Actually, none of the musicians on any given recording need to see or even hear one another and the place they perform is a small beige and blue foam lined cubby. Let me try again.... Audio space is a movie set for a fantasy fiction action hero, a "transformer". The recorded elements are discretely equivalent animated props, tape splice, sequencer and warm body alike. Add your favorite recordings to a ghetto blaster or "Walkman" and you can also transport it anywhere and into just about



For 6AV5's use a 700vct power trans. and change the 13.2k 5w resistor to 12k 5w.



any context. Bring the "Metallica" into the most menial workplace, or to Mecca (all roads...) or how about the High Sierras? Any experience, sacred or profane, can be accompanied by your most beloved chamber orchestra.

Without making any sort of value judgment about this, it is interesting to me that, unlike film (which has experienced a parallel history in many ways), either the suspension of disbelief has been total or very few have thought to question it at all. The initial use of recording was very much like taking a picture with a camera, or making a newsreel. Listening to the Moreschi at the Vatican (old eunuch singing into the horn of an Edison cylinder recorder) you will hear this clearly. Even I would think of it today as "bush recording" (recorded in the "bush"—as Don Van Vliet dubbed it), as opposed to the studio stuff, which is somehow more plebeian. *Audio verite* vs. Disneyland. In any case, the site at which we meet our music is a slippery place.

Another facet of this concerns recorded time. Whereas we easily enjoy, expect, swallow or sleepily ignore all sorts of spatial audio special effects, there is today one homogenous monolithic concept of timekeeping. The time in which music, as a whole, has become measured by is 4/4 (four beats to one measure). Even if someone were to make a record of waltzes today, its commercial novelty would be derived from the inability to count "1..., 2...,3..., 4...". At ninety beats per minute, by the way. The smallest deviation from this formula banishes a recording to a fringe market, or the cut out bin, pronto. Even the most viciously angry gangsta rap and thrash conforms.

All this is because American pop music, the dominant form worldwide today, which exists in that form because of the recording process, has overwhelmed all other traditions to a level where anything else is forcibly manufactured and listened to in relationship with it, whether intentional or not. Pop really does rule.

Back in the early days of recording, because the mechanical 78 fit just 3-1/2 minutes of "music" on a side, popular forms and dance music adapted much more rapidly to the new "reality". The technology gave an edge to fast entertainment, not because of any obvious idealism or value judgment, but simply because of the limits of what could technically be done at the time. The classical "hit" actually dates from the beginning of the century where a short popular sequence of operatic showmanship could sell a million copies. Popular stylings still had an advantage over classical, "modern" or ritual music. By the late 1950s, Buddy Holly had a "gold" record with 22 "tunes" on one LP! It's also a great record, milestones notwithstanding. Today, the arrangement, techniques and tools developed for the pop music market have affected all recording regardless of intent. A short attention span helps.

Multitrack recording, for example, has become a formula for nearly all music. Many engineers and many musicians could not imagine doing without it. This one tool has had important effects on the way live music is perceived, although I don't mean to imply that these are entirely negative. It does seem that live is too "unreliable" for many people, both for industry types and the average listener (including many audiophile reviewers!). It "never sounds like it's supposed to", like it does on the record or on MTV.

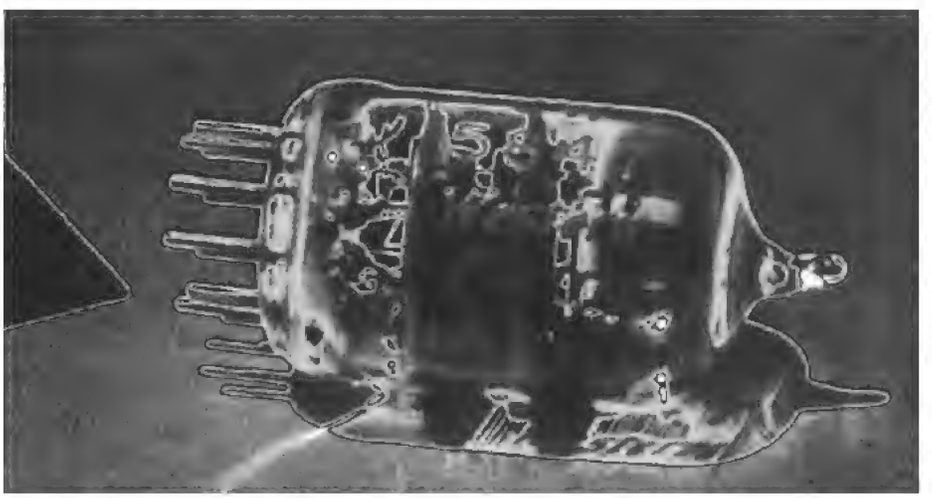
Not to mention, musicians are such a debauched and irresponsible collection of exploitable trash anyway, and why should record company people have to worry about them showing up late, intoxicated, or not at all? Or, why should a recording company, who pays for an accomplished classical orchestra at Carnegie Hall, have to put up with super expensive mistakes on the part of the talent?

Thanks to the multitrack studio, it is not at all necessary for the musicians to be able to play their instruments, much less "perfectly", or show up on time. Fix it in the mix! Absolute "perfection" and control can be had over the musicians and their efforts, to the point where the producer has become the key creative node in the music network. Remember the "Monkees"?

This is not simply a bad thing either. It has also led to a new category of composer who needs nothing but a multi-channel digital sampler, a sequencer and a mixing board. It has contributed to a condition of general mediocrity, but there are those who have become real lo-fi savants, like Beck, or Sir Mixalot, who can't "play" for shit but splice up some really good music anyway. And there is a whole mature genre of *musique concrete* that relies not on the individual virtuosity of musicians w/instruments, but upon the editing of pre-recorded sounds and textures. The hardware floats underneath someplace. I want to be fair here, the trend, however, is that it always sounds the same even when it's totally different! Amazing!

Like I said, I'm a cynical bastard.

Having said all this, and despite the fact that the recording has changed our relationship with musicians, with musical tradition, with the architectural space where it all happens, with the quality and quantity of it, and with the clothing we wear and the positions it assumes in our domestic and sexual lives, and how much we pay and who gets it, it is possible to get connected to the vital element we believe music contains with recordings. Occasionally, we even experience something remarkable.



One might think this a strange way to begin an article about amp design, but I never expected anyone to take me seriously in the first place!

This particular project will challenge some currently fashionable design dogma that I am in part responsible for. That's key. I would like to present a pair of designs that use common as dirt beam tetrodes and are parallel single-ended arrangements. Oh yeah, these amps will also incorporate the use of negative feedback. They both use inexpensive stuff and I have gone out of my way to eliminate as many opportunities for tweaks as I am able (direct coupling and minimal circuits). These amps also have shocked me, and others too, for how good they work and sound. You might consider these little guys as an elegant sequel and a performance upgrade to the "morrison micro", which fulfilled a very similar musical compromise.

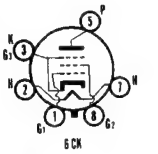
I became intrigued by screen-drive tetrode/pentode operation several years ago while I had the good fortune of borrowing one of David Berning's PP amps from my friend, Mike Trei. I used this amp to drive my bass cabinets (because I sold off my own bass amps to make the rent...). Despite the class B operation (which I remain underwhelmed with...), it worked pretty good on the low end! It kind of sucked on complex material through the midrange, so I never seriously considered using it full range, but even so, it was a sweet sounding forgiving amp with great bass. I understood that this amp used a screen driven pentode output stage and that perhaps this contributed some of its positive aspects.

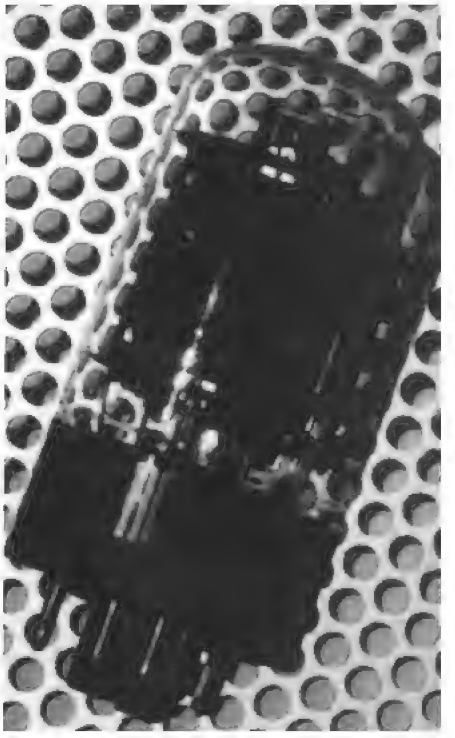
One can actually drive any and all of the control elements in a multi-grid tube. It changes the transfer characteristic radically and not always for the better. "Screen-drive", or the method of applying a control voltage to the screen instead of the control grid, is an old trick that RF engineers used as a high quality method to modulate a carrier signal with CW or voice. It's basically a form of quasi-triode operation with some options. I'm not entirely sure how Berning got a patent on it back in the day, because there is a large amount of prior art in this case. However, no question at all that he was the first to specifically apply it to commercial audio amplification. With the right tube the advantages are, 1) extremely linear operating points w/o feedback, 2) ease of use in simple dc circuits, and 3) unusual flexibility in modifying the performance of an active stage (lots of opportunities to splice in feedback or filtering for specific purpose with the extra grids and cathode).

My main gripe about the way Berning applied this arrangement was the class B operation and an overly complex driver stage (that relied on feedback to get its reward), which in my opinion was responsible for the less than remarkable performance of this amp in the middle and top. Lots of feedback made the bass excellently tight. I think Berning did a very good job (all those many years ago...) at a very reasonable price. However, I was interested in whether or not "screen drive" might be pushed beyond this amp.

Just to touch on a subject that I have harped on about in other articles, I would reiterate that you can't fix the past. Feedback, not anywhere near as evil or as useful as folks generally seem to spout on about these days, is only really helpful (in sonic terms) in those amps that don't really require any to work well. It has a vital place as an impedance transforming technique (for pentodes, this is crucial) and as an aid to retaining ac/dc balance over a period of time in a PP or DC coupled amp, both of which are important applications. Its usefulness in reducing amplitude distortion and phase shift is completely overstated, and the cost of performance complexity and radically worsened high order distortion spectrum and poor high frequency stability is too great, especially in an amp that clips all the time. Those things all relate to good sound.

SYLVANIA TYPE 6AV5GA
12AV5GA
17AV5GA
25AV5GA
BEAM POWER AMPLIFIER





Now, all power amps clip constantly and NFB makes it BAD. Especially very fast clipping transients. Better to design right for the open loop pre-feedback condition. If feedback is to be used it is NOT primarily for error correcting, but to alter the functional behavior in a useful way (such as output Z or for filter networks).

It has not been my experience that 3 to 6 dB ever hurt a well designed triode amp, and did offer modest improvements. Plate-loaded pentode output stage amplifiers must use NFB, but even here there is a proper amount, NOT the rote 20db most tube-amp designers rely upon.

In any case, a severely bandwidth limited triode amp, with a shitty power supply or output transformer, almost always sounds better without any, than with, although why anyone wants such an amp is a good question on its own (I sense the Asano ninjas drawing their weapons...)??? The standard EE argument about efficiency of operating point and use of feedback to error correct can be thankfully ignored in a DIY situation, so I won't waste any more of your time.

The first amp circuit I want to introduce you to (schemat. #1) is a dc screen-drive amp built around the 6AV5 or, its slightly bigger sister, the 6FW5. These octal tubes are some of the most unheralded groovy little power tubes and I just can't imagine why. Triode wired, they compete with anything. Running as beam tubes, they kick butt. The only reason I can imagine why the cheapskate audio world hasn't latched on to them is that they have "TV tube" stigma. I don't have any problem with that! And, because they were commonly used as horizontal amplifiers from the black and white age on, there are droves of them at very fair prices. General Radio, by the way, recognized a top performer and extensively used them in their test equipment.

I am so exhausted from the sound of politically correct propeller-heads expounding upon the virtues of single-ended amps, that absolutely must employ a directly heated triode w/o feedback, etc., that I feel like vomiting. I know that I am in part responsible for this and I will continue to build amps around them no matter what. But still, I feel that the point was missed

AMPEREX TUBE TYPE 5847

The 5847 is a high-gain, miniature pentode designed for applications in broad-band amplification where its high figure of merit is required. It is a plug-in replacement for the type 404A. The 5847 is intended for replacement purposes only in existing equipment. For new equipment designs, the Amperex type 6688 is recommended. The 6688 has a different base pin arrangement and higher transconductance.

5847

GENERAL CHARACTERISTICS

ELECTRICAL

Heater Voltage		6.3 volts	
Heater Current		300 mA	
Direct Interelectrode Capacitances	Without External Shield	With External Shield (EIA #315)	
Grid to Plate (max.)	0.05	0.04	μμf
Input	7.0	7.1	μμf
Output	2.5	2.9	μμf

Characteristics & Typical Operation

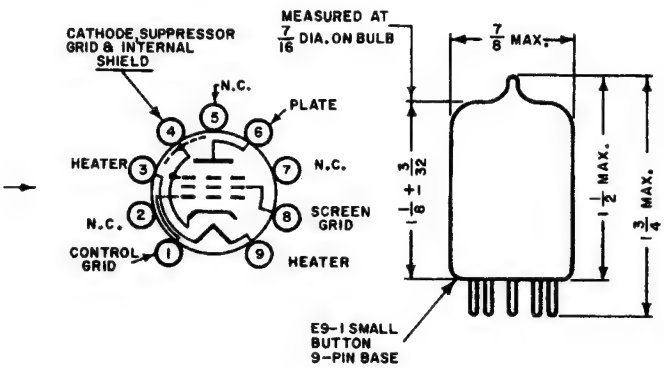
		*	
Plate Voltage	150	160	volts
Screen Grid Voltage	150	160	volts
Cathode Bias Resistance	110	600	ohms
Control Grid Voltage	—	+8.5	volts
Plate Current	13.0	13.0	mA
Screen Grid Current	4.5	4.5	mA
Transconductance	12500	12500	micromhos

MECHANICAL

Base	Small button, 9 pin
Max. Overall Length	1¾ inches
Max. Seated Height	1½ inches
Max. Diameter	7/8 inche
Mounting Position	any

MAXIMUM RATINGS (Design Center Values)

Plate Voltage	180 volts
Plate Dissipation	3.0 watts
Screen Grid Voltage	180 volts
Screen Grid Dissipation	0.75 watt
Cathode Current	35 mA
Heater-Cathode Voltage	50 volts
Grid Resistance	0.1 megohn



* Operating conditions to minimize gain variations due to supply voltage fluctuations.

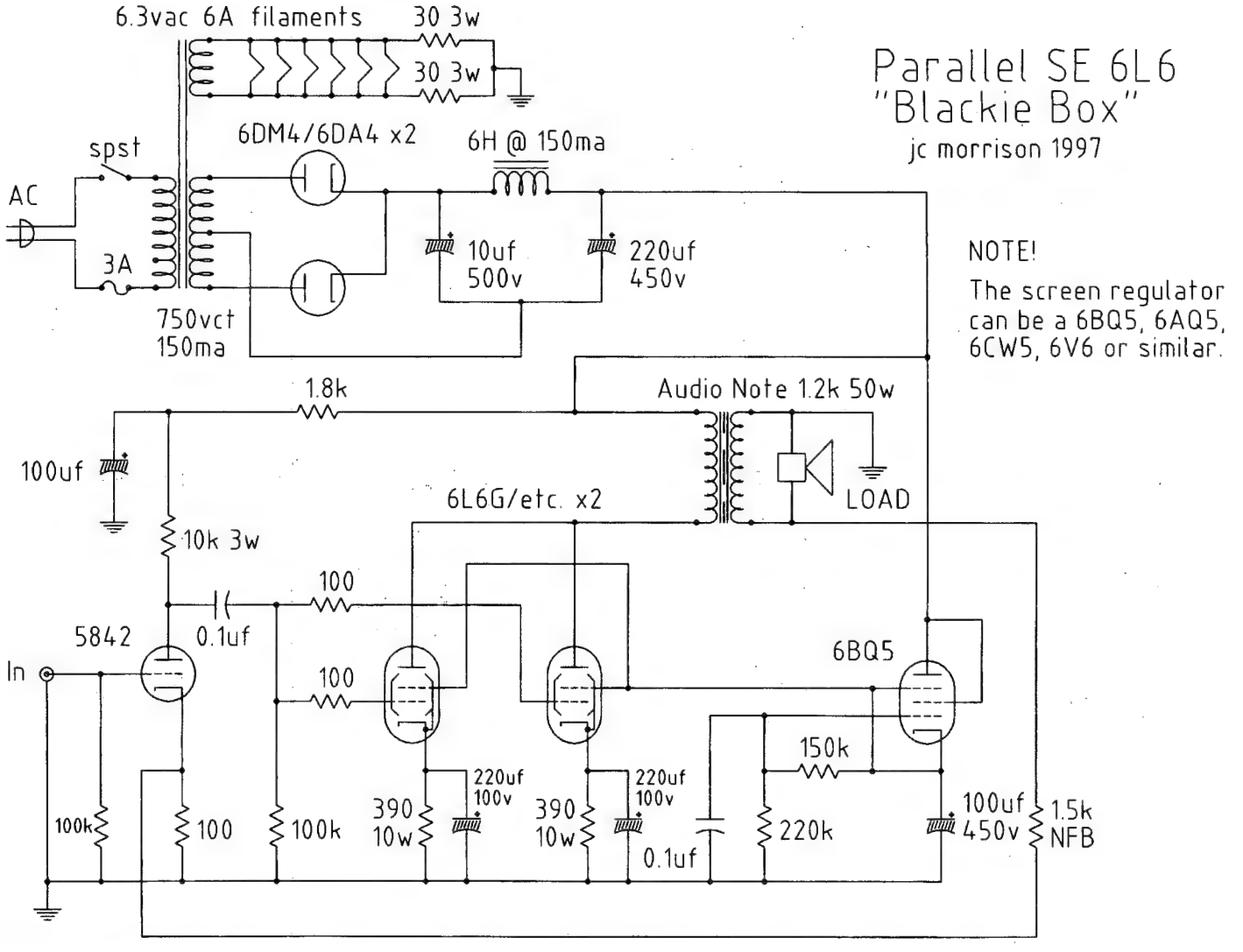
somewhere along the way, namely that it isn't the stuff, the tubes, the circuits... its the attitude! Well, just for you SP readers, I had in mind to come up with some smoking good little multi-grid amps that didn't cost much or require a degree to complete. Brown clothing for mono operation is optional.

The output transformer is the One Electron "UBT-1", which has to be the under $100 red hot deal at the moment. There are no coupling caps so I don't need to hear any crap about which ones are better or worse. In my experience, caps never made as big of a difference as did many other things. And there are so many good caps now! Besides my beloved REL polystyrenes, there are Hovland and Audio Note and MIT. As far as power supply caps go, I used a Cerafine dual because it was the only 500v cap I had handy and I couldn't fit stacked Panasonic TSHA's in the Dynaco Mk III chassis I gutted for use with this circuit. I absolutely recommend Panasonic TSHA's for all power supply applications. You can get them from DIGI-KEY. I do not bypass large caps, if they don't do what I want at hi freq., I don't use them.

The most important tube in any amp is the first one, and in this case I chose the Western Electric 404A/5847. My brother, Herb Reichert, introduced me to this tube 8 years ago when he built a phono stage around it. It was too microphonic (rattling screens) and he gave it up eventually, but not before we had heard this magnificent sound! I have been wanting to do a higher level circuit with a 404A ever since. These tubes were used in the famous TD-2 VHF repeater (along with the 417A), which guarded the free world from the red menace prior to the satellite age. They are meant to be run at high currents (read wide bandwidth) and can work well enough open loop in no-feedback audio amps. That is unusual for pentode voltage amps. If you have trouble locating these tubes, other candidates are the 6AC7, 6688, 7788, 6CL6 and 12BY7. Any one of these can be adapted easily to this amp, and while different, all will certainly sound great.

The first stage uses 1/2 half of a 6DJ8/6922 as a plate load for the 404A. I used the smallest cathode resistor I could get away with (without losing all gain from the lower half) on the 6922. It occurred to me that a 6AQ8 or a 6BK7 might allow the same current, at a higher impedance and at roughly the same capacitance, for more gain from this stage. Since the amp worked out, I didn't spend the time for checking it out. This would be the one change I would look into now because there are a few more watts to be squeezed out of the amp and the sensitivity is on the medium to low end of the scale. For a CD only system, the amp works really great as shown.

You can see that the stage looks vaguely like an "SRPP" arrangement. The reasoning for this was to keep the first stage output impedance as low as possible so as to keep



the bandwidth up. The Z out is the plate resistance of the 404A in parallel with the total source impedance of the 6DJ8 + cathode resistor combo. In comparison, a 47k plate resistor knocked nearly an octave off the bandwidth (although the gain was higher...).

I adjusted the biasing of this first stage to get the best X/Y phase trace for both stages ahead of the tranny at 30 kHz (a modest broadening, at most a 1/16"). I take this to mean that the driver stage behaves itself until a bit less than 300khz (one order of magnitude). The output transformer then represents the primary high and low frequency poles in this amp and, for the most part, characterizes the behavior (because the voltage amp and output stages are much wider bandwidth).

The UBT-1 is remarkable for such an inexpensive unit and the small amount of feedback used causes no significant problems until 160khz. The small amount of overshoot seen on higher frequency squarewaves is due to the phase turning around up there. There are amps for sale for big dollars that are much worse.

Now, I don't really care for "SRPP" both for how it generally sounds and from my own engineering aesthetics, but it accomplished what I needed here and I admit it. I used the other half of the 6922 to regulate the screen voltage on the 404A. The grid-stopper is to bandwidth limit the regulator voltage so I didn't need to bypass with a cap (zener crap). Regulating or separately supplying the screens is always a good idea with a pentode in my experience. The point here is to get 125-150 volts on the plate of the first stage, 100 volts on the screen, and use the plate potential to correctly "bias" the screens of the 6AV5/6FW5s. One of the many excellent features of this tube family is that it will draw current at low screen voltages. A 6L6 type tube will need something more like 225-250 volts on the screen to pull enough current.

The control grids of the 6AV5/6FW5 are simply grounded and the cathode resistor is calculated (in this case...) to drop the intended bias voltage for safety. One note about this: I am over-dissipating the tubes quite a bit. The normal Pd of a 6FW5 (the tube used in the amp) is 18 watts. I am running them at 25 watts each. No problem. At roughly $3.50 a tube, I do not lose sleep. Nearly a year later, no problem. But I held back from grounding the cathodes directly, which can be done in a screen-drive circuit with properly adjusted screen voltages, because I intended from the start to direct couple and burn the tubes up for my own twisted reasons.

If you use 6AV5's you will have to limit the B+ to 400 volts instead of the 490 I used here. I would limit the dissipation of 6AV5's to 20 watts each. Among the other great things about this tube is the low grid to plate capacitance. This makes parallel


Pentode Babe of the Year 1997
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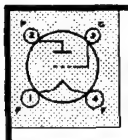
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operation much less problematic than say a pair of bi-plate 2A3's. Parallel operation of vacuum tubes does NOT have to be a problem if you pay attention to the way you drive them.

The amp put out 10 watts at 5% THD, 8 watts at 1% (HP 334A). My crappy Heathkit signal generator is responsible for some of that. Obviously, this could be improved upon with a little more gain out of the first stage, mostly just for more power. But the sound of the amps was gorgeous. Very un-electronic. I brought these amps to the Philadelphia Triode Show back in the early spring, they didn't get much attention (they were auditioned briefly at the end of the day) but I was told, by those that heard them, that they were real contenders against the many 845 amps that were there. Obviously, I thought that they blew away everything except, of course, for big daddy Komuro's dc 300B (w/permalloy outputs) amps, still one of my all time favorite designs.

The next amp is a parallel single-ended 6L6GC type amp, which means that you can use any of that family, even 807's with a socket change. This amp has a good story behind it. I have a friend named Blackie, who is one of the top guitar amp technicians in NYC. He serves your favorite rockers, all of them. Anyway, we've been hanging out for some time and at one point, the topic of building an amp for his home came up. Blackie asked me, "What would be the most unpopular and out of fashion hi-fi amp I could build?" That was easy, thinks I, "A parallel SE amp with guitar tubes for output devices." So we designed it around the Western Electric 417A/5842 (again, from the cold war arsenal...) and 6L6 family. Other features include a 6BQ5 screen regulator and TV damper diode rectification (my fave...). This amp sounds so good, it continues to impress. It absolutely has enough guts to drive most real world speakers. The schematic (schemat #2) is very straightforward without tricks. Blackie built it into a lean green hammertone machine. His wife, Betty, approves and insists upon single-ended pentodes for all her serious playback.

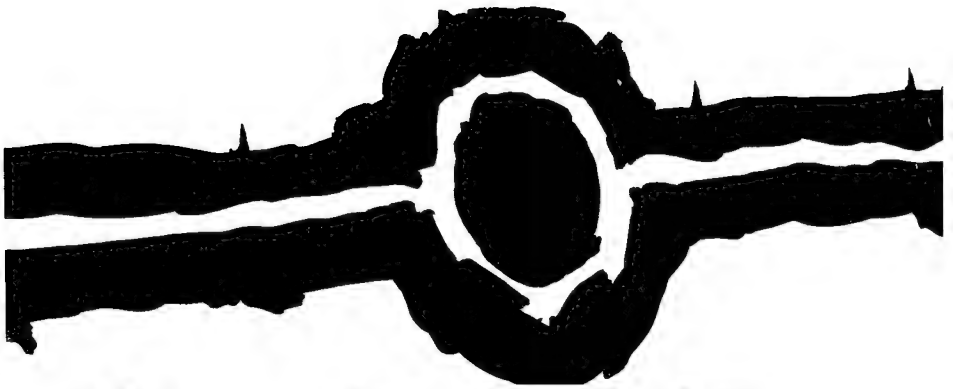
Blackie, by the way, makes a mean guitar amp. It's a Class A PP 6550 head, with glow tube regulation for screens (dual OD3's), a trick tone section, and a unique appearance (Plexi-glass cage and bottom cover that allows you to see the regulators and his gorgeous point to point). He can be found at "Tubesville" 153 Ludlow St. New York, NY 10002 tel. 212-529-7345.

Back to the amp, we selected the Audio Note 1.2k 50w single-ended output trannies, which turned out to be excellent performers. The power transformer and the chassis are Hammond units all purchased from Angela Instruments. The result is compact and practical. The regulated screen supply also did make a big difference in the low end performance. NOS 6L6GC's are not all that easy to track down these days, but apparently it is still possible to get 7581A's, which are the same thing. These are 35 watt dissipation tubes and you can bias them all the way up. The cathode resistors I specified are really conservative. They could be reduced to 250 ohms if you are daring and have the "GCs" (forget the Chinese 6L6's for this amp). Sovtek 5881's, as well as the rest of the 6L6 family, can also work well here but I would stick with the 390 ohm cathode resistors. Great tubes for hi-fi audio, I don't know why they have not caught on again.

Of the two amps, the "Black(ie) Box" is simpler to make and more punchy and powerful. It is a good performer with impressive measurements. The screen drive amp is more subtle and delicate, but also a bit more work. Both are solid workhorses that sound great. Betty and Blackie are hard-core daily listeners. My friend, Kato Hideki, uses the screen drive amps full-time with Tannoy monitors in his recording setup.

In closing, one of the really positive things that can be said about the hi-fi hobby is that it encourages one to pursue the hardware/software thing with a demanding attitude. "I want to love it!" Building the gear or making your own recordings is a radical statement of this, and re-involves us with the quality of the experience. Audio design is not easy and requires one to incorporate a number of seemingly contradictory forces, but really good work also needs this: an individual effort to go after the remarkable.... How do we nail this down into an approach?

In my own experience that is sort of like asking some big fat French guy to pass the potatoes, but he hears it as "Your mother turns tricks for centimes." It's just fraught with blind turns and misunderstanding. But, I do believe it amounts mostly to making the attempt, even though we know it will slip away.



The Feral Eye

by Herb Reichert, Audio Note NYC

I have a confession to make. By any rational standard, I am not qualified to design an audio amplifier. I have built every feasible circuit. I have read dozens of books and even studied in the classroom of my mentor Arthur Loesch. Still, after almost twenty years of trying, I feel radically unprepared for the chore.

I am a slow learner and I have the worst memory in the world, which may be an asset but it sure is embarrassment. I sound like a darn fool when discussing mathematical problems. I continue to ask the same dumb questions and rely on the advice and consul of guys like Steve Berger, J.C. Morrison, Komuro, Andy Grove, Kondo and Nobu Shishido. Without their help this amplifier would not exist.

On close examination, the only real talents I can muster are a basic ability to paint pictures and a potential to (sometimes) be quiet and listen. My (imagined?) capacity to glimpse a painting, read poem or visualize the forces of nature is the source of my belief that I can indeed design audio amplifiers.

The secret is forgetting

In order to make anything of exceptional value the maker must be untethered. As long as we truly believe that there are definite rules or concepts that govern our endeavors, as long as we are conscious of any notion that says we can't do something, we will mostly fail. To be free and create something original, we must embrace purposelessness. In fine art, when purpose is too much in evidence, the ART is no longer there. The creation becomes a machine or an advertisement. Beauty is replaced and the not so beautiful hand of the artist becomes altogether too obvious.

In art, the simplest ink sketch — even if seemingly very crudely executed — can stimulate deep feelings and engage the focus of our whole being. Amplifiers must do the same and present music as if we were facing our own personal nature directly. When we listen to music in the home we should feel every pulsation of it as if it belonged to us. Reproduced music attracts our attention most easily when we can "identify" our own nature in it. Therefore we should let our own character resonate in the design of the amplifier.

When the new amplifier is very good, the music comes from the speakers like "the breath of life". Music reproduction should feel direct and be perceived as having a similar substance and material character as a live musical event. The presence of the musician should appear before us.

Working in the lab

At the work bench, I feel like a student working on a science project in Dr. Zarkov's lab. The solder fumes enhance this vision. Sometimes I imagine that a tube is like a lens and the signal is a delicate energy form, like pulsing light. I picture a field of flickering, throbbing light in front of me. Looking at it, I ask myself, what is the simplest, most effective way to build a projector. How can I make the energy bigger, how can I stimulate the loudspeaker, without losing the signal's proportions and intensity?

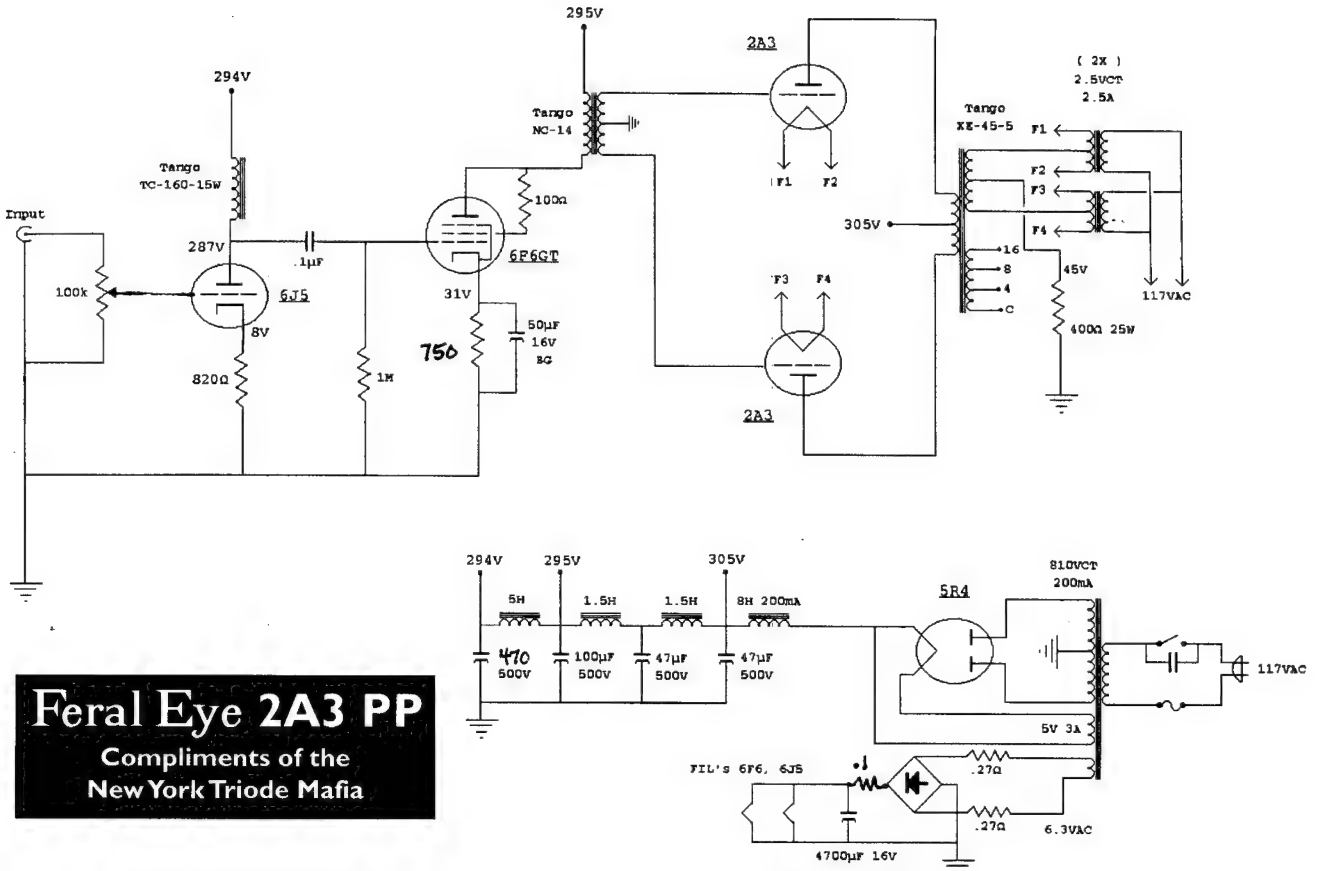
For me, the process of designing an amplifier starts with making pictures and setting my mind at ease. I need to feel I can do this. I imagine a nearly invisible, vibrating, electromagnetic slipstream forced to pass through a series of lenses and I suppose that I can compare the image of the original on one side to the thinner, bigger expanded version appearing at the other side. I try to keep a dynamic energy model in my head. I think power and energy not sinewaves. I struggle to visualize the effects of a series of partially mirrored pieces of glass (filters) on the energy. I picture a river of energy impressed on the load. I try to invent lattices of components that do the least damage to the original proportions of the energy stream. The components, the tubes and the transformers must be in good alignment. They must harmonize. I look for an ecology, a synchronous structure, a simple mathematical model and the most benign arrangement of all the physical aspects. This kind of mental imaging is, I believe, critical towards making quality amplification.

Blink, blink, blink...

The Feral Eye is being designed as a archetype amplifier for *Sound Practices* readers who want to experiment with push-pull. I hope you don't find it too strange to try yourself because this design has a few excellent qualities that are seldom found in push-pull amplifiers. The goal was to maximize PPs strengths and minimize its weaknesses.

The Feral Eye is a concept amp. It was conceived by me but several of my friends helped me bring it to fruition. *Feral Eye* is really an amplifier format designed for home builders as an inspiration towards their own creation. Look at its architectonic aspect. It represents my thoughts about what it takes to make a push-pull amp sound less shattered and artificial. It comes out of a desire to look again at an underdeveloped technology and see if something better can be done with center-tapped primaries.

Before I ever built a SE amp, I had a "paradigm shift" while listening to records at a friends house. This unusual friend had an AR turntable, Decca cartridge, RCA type preamp and a little "Bud box 2A3" amp driving Western Electric 755As. When I asked him why I loved the music so much today he said, "The only natural way to split phase is with a transformer or a split-load inverter!". Looking closely at the Bud box I noticed the UTC LS-55s and a UTC interstage transformer.



Several years later...

My best amp design ever was a transformer coupled parallel single-ended 210/310. Nobu's designs were the inspiration for this amp. This topology made for an even more unconstrained sounding amp than the *Flesh and Blood*. Tone character and dynamic contrast were extremely natural. At the time I designed this amp I was reading a lot of Norman Crowhurst. Since then, I remain convinced that a tube-iron-tube-iron lattice can reveal subtleties of musical expression that more conventional R/C (or direct) couplings miss.

The Feral Eye amplifier is a topology that can be used with almost any Class-A power tube. Believe me, you have not heard how psychedelic and colorful the 6L6 or the EL-34 can sound until you try them with this configuration. Using the "cathode feedback" secondary coil hookup with the above pentodes (in triode) will give you an amp with an extraordinary high frequency integrity and the kind of bass you never thought was possible with tubes.

Summer of '97

Most of my current amp design belief system can be seen in the schematic.

The following are some of the poetic ideas that informed this design:

1) Keep resistance values low. If you can replace a resistor with a piece of iron and a coil...do it! Resistors dramatically effect tone character and resolution. The worst offenders are high value plate load and cathode resistors. This is not simply an issue of metal film vs. carbon composition. It is the value! Using plate resistors of greater than 2xRp, despite issues of measured THD, make triode gain stages generalize and sound rough and jumpy. The trick is to reduce the value of plate resistance to the point where the transconductance (and probably THD) are maximized and then reduce it a touch further.

Choke is good

The same principle applies to the A/C impedance of the choke in the first stage. use as little inductance as necessary and adjust the plate current of the stage until it "opens up" sonically. Radical "henry changes" in amplifier plate loads almost always require adjustments in overall amp tuning. This kind of work can be over my head so I asked J.C. to check my arrangement on his bench. With a stage like this at the beginning of a three stage amp, you must be certain to provide adequate decoupling or you will experience some low frequency motorboating.

2) Use low mu triodes. (This should have been number one.) Low mu and plate loads between 1x and 2x Rp give whole, complete, unedited type reproduction.

3) Avoid differential amplifiers. My friend was right. Transformers and for those on a budget, split load inverters, give a push-pull amp a more "together", less shattered sound character. Transformer coupled amplifiers, with quality iron and well calculated time constants, sound considerably more intact and continuous. The most noticeable difference between live and reproduced music is that the real thing doesn't sound like it has been taken apart and put back together. Hi-Fi as most of us know it has that "Humpty-Dumpty" sound.

4) Keep the parts count minimal. The transformer as phase-splitter and driver serves several very useful ends. In this design it replaces at least four resistors and two capacitors. It allows for greater volt-

age swing and extremely gentle clipping.

5) Because of the zero crossing inherent to PP designs I probably should have called this amp *The Blinking Eye*. My basic feeling about push-pull vs. single-ended is that a PP amp designed by a perceptive, discriminating designer will always sound better than a SE designed by Mr. Radiotron. Bottom line, I am certain that SE has certain very tangible advantages when listening pleasure is the main criteria. PP has a slight edge when it comes to adaptability.

6) Use choke input filters. To me they give a sense of relaxation to the music making. They take the virtues of tube rectification one step further.

©ourage under fire

Many amps with fixed bias and global feedback have really violent and annoying clipping characteristics. This amp, with the single-plate 2A3s and RCA 5R4GY rectifiers has what I call a "lubricated" clipping characteristic. It has a sort of James Bond like poise when it runs out of power. *The Feral Eye* was built by the hands of Steve Berger (Aprilsound). He laid out the chassis, bolted it together and soldered it with care and good jazz insight. Berger, Komuro and J.C. all participated in the design of the first two stages and the power supply. The creation of this amplifier was precipitated by the design team's love of, and experience with, the three pieces of Tango iron employed. I designed this amp because I have a special affection for the results I achieve when I use the Tango XE-45-5 and its center tapped secondary feedback coil.

Connecting the filament transformer center taps to this coil not only reduces distortion at the frequency extremes and lowers the output impedance but it also allows the designer to use A/C filaments in push-pull with very low values of A/C ripple left on the output.

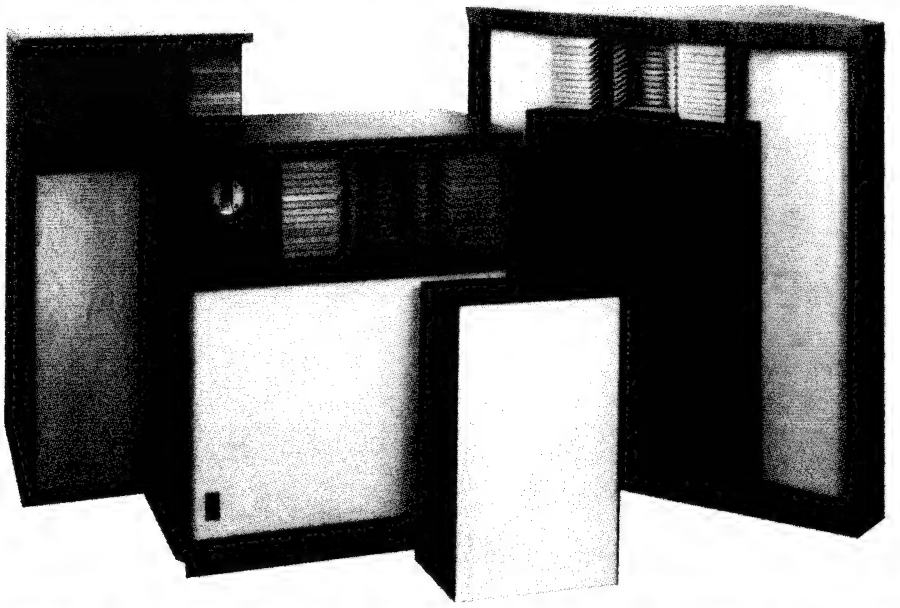
To hook them up correctly it is important to measure the gain of the amplifier with the heater trans CTs connected to alternate sides of this coil. The connection with the lowest gain is the correct wiring and the one with the higher gain is the positive feedback version.

The driver stage, with the Tango NC-14, can alternately employ the 6L6 or 6V6 tubes. My personal favorite is the 6L6. Go mad. Try the 6L6 driver stage and a 6L6 (ultra linear) output with your Quad ESLs. Do not let the current get too high on this stage or the NC-14 core will saturate on climaxes. The 6J5 is perfect with the TC-160. I love this stage! It is so good you can use it to improve almost any amplifier.

You can use other brands of iron. But! If you lose the secondary feedback coil you might as well switch to single-ended. The beauty of this design is in the use of iron.

I promise you that, if you build an amp, with this arrangement of metal, you will experience a new type and quality of music reproduction. *The Feral Eye* plays music very differently than most of us are likely to have heard before. It sounds more full, whole and complete than any traditional PP amp I have experienced. It is very rich sounding. It loses a bit to quality SE amps on pure magic and texture but makes up for the loss by driving a broad range of loudspeakers. Regard it as a modest gift from the New York City Triode Mafia.

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It never ceases to amaze me how far audio technology had actually been perfected by the early 1950's. Companies such as RCA, Western Electric, Fairchild, Altec-Lansing, Langevin, among others, had made enormous strides in terms of quality sound reproduction. One company above the others always seems to be the unsung hero for also advancing the audio state of the art: the Ampex Corporation of Redwood City, California. It is still difficult to believe that nearly all of those treasured, highly praised (and now reissued) RCA Living Stereo and Mercury Living Presence recordings were recorded on Ampex Model 300-3 3-track tape machines during the Eisenhower era.

Ampex deserves more recognition for bringing about the tremendous technical and social impact that audio, video, and data magnetic tape recording has had upon us all. High quality stereophonic and multi-channel sound, modern LP recording techniques, Cinema-Scope sound, and videotape recording, all owe their development in whole or in part to Ampex. The professional versions of their machines exemplified the superb quality of American audio engineering and manufacturing know-how that was the envy of the entire world.

Indeed, Ampex deserves most of the credit for perfecting and marketing modern magnetic tape recording technology. Prior to the wide-scale introduction of tape recording equipment in the U.S. in 1947, 12 and 16-inch 33-1/3 and 78 RPM disk transcriptions were the primary storage media for professional sound applications, along with optical recording techniques for film sound. During World War Two, the Germans, through the efforts of AEG Telefunken, had developed the first high quality audio tape recording system using high-frequency AC bias, known as the Magnetophon. As a spoil of war, the U.S. Army Signal Corps captured and evaluated a number of these machines, one of which was subsequently demonstrated at an Audio Engineering Society (AES) meeting in San Francisco. Ampex Electric, who had manufactured motors and generator units under government contract for the military during the war, was looking for a new product to carry them through the post-war period, and upon hearing the startlingly realistic high fidelity sound reproduction provided by the Magnetophon at the AES demonstration, quickly sensed that there would be a tremendous future for



The Groundbreaking Ampex Model 200 Magnetic Recorder

this new technology.

Short on cash, Ampex found a willing investor in Bing Crosby. Crosby, who apparently had been something of a stickler for the audio quality of his popular radio show, was looking for a recording system which offered superior fidelity and ease of editing compared to the 16-inch transcriptions then in use to record his show for rebroadcast. He personally bankrolled the fledgling Ampex Electric Corporation to a large extent during the company's early tape recording years, and for many years thereafter was an enthusiastic proponent and supporter of the company as well. An early Ampex advertisement shows Crosby happily using one of their portable 600-series machines.

Alexander M. Poniatoff, the president and founder of Ampex, along with his team of engineers, (his initials plus "EXcellence" were the basis for the company's name), carefully studied the shortcomings and merits of the German Magnetophon design, and in 1947 with Crosby's financial backing, introduced the landmark Model 200, with the first production units delivered to the American Broadcasting Company (ABC) Radio Network.

To some extent, the Model 200 was to establish the basic mechanical design of the tape transport system for all future Ampex professional recorders. Using three motors, with one each functioning as torque motors for the take-up and supply reels, and one driving the capstan, and with solenoid-actuated braking, these units were immediately recognized within the audio industry as offering the finest sound recording technology available to date. To Ampex collectors, the 200 is analogous to a Western Electric 91A amplifier; extremely scarce and desirable, as only 112 of these machines were built.

Unfortunately, I wouldn't even bother looking for one, as most were scrapped out long ago or are now in the caches of collectors. Really overdesigned for the task at hand, with oil-filled capacitors in the record/reproduce electronics power supply, and a beefy push-pull 6L6G bias/erase oscillator, these units were truly the cutting edge in the late 1940s for high-fidelity sound recording and reproduction. With a single tape speed of 30 ips, the Model 200 was the only Ampex unit manufactured in which the tape wind was "oxide-out" like the Magnetophon. All subsequent machines (beginning with the Model 201) were built with the conventional "oxide-in" format.

In 1949, Ampex introduced the Model 300 as a lower cost and more versatile version of the 200. The 300 was an upgraded machine compared with the 200, featuring redesigned tape heads, new electronics, and a massive, improved two-speed tape transport mechanism. The 300 was the machine that really launched Ampex into the recording studio, cinema sound recording, broadcast, and telemetry/data recording markets. With monaural console-mounted versions vaguely resembling a washing machine with a hamper door in appearance, this was the first tape machine to be configured for multi-track recording, and 1/4-inch half-track, full-track, two-track, and 1/2-inch three-track versions were built in large quantities. The 300 was also the basis for the impressive-looking Ampex 3200-series tape duplicating systems, introduced in 1954.

The first Model 300 was delivered to Capitol Records, and all of the major

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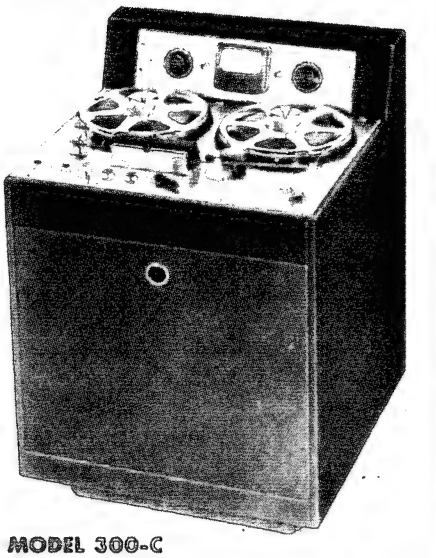
Standard model Ampex Recorders have ample range to record perfectly the overtones of all musical instruments. Every sound, tone and voice, remains natural to human ears. Special Ampex Recorders having frequency ranges beyond the audible spectrum are available; many have been built for telemetering applications up to 50,000 cycles!



MODEL 200

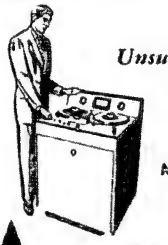
Ampex Model 200 is often referred to as the recorder that put Bing Crosby on tape. It was the first recorder built in the United States capable of exceeding requirements for broadcasting reproduced music and voice at true-to-life fidelity. Complete push-button operation. Unequalled for ease and speed in editing critical program material. Model 200 is in a class by itself and has set the standard by which all other tape recorders continue to be judged.

MODEL 201 Conversion Kit incorporates latest Ampex developments for use on Model 200 units now in service. Model 201 is available also on order.



MODEL 300-C

Ampex Series 300 is available in console, rack or portable types. It is available in dual tape transport speed of 30 and 15 or 15 and 7½ inches per second. At 15 i.p.s. flutter and wow is well under one tenth of one percent r.m.s. measuring all flutter components from 0 to 300 cycles using a tone of 3,000 cycles. Series 300 can, on special order, be furnished for multi-channel recording requirements on other than quarter-inch wide tape.



Unsurpassed FOR
RECORDING-BROADCASTING
TELEMETERING
INDUSTRIAL RECORDING
MULTI-CHANNEL RECORDING
LABORATORY RESEARCH
AEROPHYSICAL RESEARCH

AMPEX

STANDARD OF THE GREAT RADIO SHOWS

AMPEX ELECTRIC CORPORATION
1155 HOWARD AVENUE · SAN CARLOS, CALIFORNIA

recording labels quickly followed suit. Monaural versions of these machines used the series 554 electronics, which were relatively similar to the electronics employed in the Model 200, but with much improved distortion performance.

Multitrack units used the 350-series electronics which were to become the Ampex standard for record/reproduce electronics until the late 1950's. Using a combined pentode/triode record/playback circuit topology and vacuum tube rectification, these machines are capable of absolutely stunning sonics, as RCA and Mercury well knew, and if a 55 to 60 dB signal-to-noise ratio doesn't bother you.

Model 300s are still around, although their quantities are dwindling, and transport parts have become somewhat scarce. Incredibly reliable and smooth-acting self-energizing drum braking was pioneered by Ampex for the 300, and was always regarded as a major hallmark of the Ampex design.

One problematic feature of these machines is the indirect capstan drive assembly, which used a large rubber-tired capstan-flywheel assembly, friction-coupled by a solenoid to the pivoted hysteresis-synchronous capstan drive motor. Over time or through improper storage, the rubber tire lining the capstan-flywheel can develop hard or flat spots which will severely degrade the wow and flutter performance of the machine. Replacements for this part are in very short supply and expensive, although I have acquired junked 300s which had perfectly good tires. When buying any 300-series machine, always be certain to check the integrity of this tire, as it may be a long time before you can locate a good spare. Perhaps a vendor exists who can resurface or replace the rubber on this component to Ampex specifications; if anyone is aware of such a service, please let me know.

Ampex used this indirect capstan power transmission scheme to obtain very low tape flutter and precise tape speed adjustment by varying the motor pulley pressure on the rubber tire and observing the results with a strobe disk. However, the long-term speed stability was never really that good with these machines, and a retrofit kit was later offered by Ampex to convert them to a less troublesome direct capstan drive system. Nevertheless, the 300-series units are a real classic in the history of high-fidelity sound recording, very cool looking in a 1950's industrial sort of way, and well worth owning and maintaining if you have the space.



Model 351

SPECIFICATIONS:

(Note: specifications apply to all three models except where noted)

Speeds	Dual speeds: 7½ and 15 ips or 3¾ and 7½ ips
Frequency Response	± 2 db, 30-18,000 cps at 15 ips
Signal-To-Noise	55 db at 7½ and 15 ips*
Flutter and Wow	Below 0.15% rms at 15 ips
Timing Accuracy	± 0.2%
Crosstalk Rejection	Model 354 or 351-2 : 65 db at 400 cps

* 60 db at 7½ or 15 ips for Model 351 full-track



Model 352

Model 354

350 SERIES

. . . a complete family of rack-mounted, console, and heavy duty portable recorder/reproducers designed primarily for the broadcast and recording industries. The 350 Series is accepted as the world standard of the broadcast industry. Thousands of units are in professional use throughout the world. Includes Ampex "Four Star" one year warranty.

FEATURES: The basic tape transport is common to all three models — 3 motors including direct drive by hysteresis synchronous motor — has pushbutton, relay-solenoid operations for remote control — reel-size selector switch automatically adjusts tape tension for various reel sizes — non-wearing tape lifters, fast wind and rewind (rewinds 2,400 feet in just 60 seconds) — all controls interlocked to prevent jamming — basic electronics with separate record and reproduce amplifier electronics permit easy monitoring at input or playback.

ADVANTAGES: Meets broadcasters requirements for long-life, ruggedness, and dependability. Wide variety of models, each designed to meet specific professional requirements of monophonic or stereophonic recording and reproduction in broadcasting, recording, education, business or research.

MODEL 351 . . . a monophonic recorder/reproducer available unmounted, console-mounted or portable — two-channel stereo model (351-2) available unmounted or as a portable.

APPLICATIONS: For monophonic (351) or 2-track stereophonic (351-2) recording and reproduction — designed primarily as a broadcast recorder for heavy, continuous duty operation requiring exacting performance characteristics — has also found wide use in recording studios, education, business and research.

MODEL 352 . . . a tape playback-only unit available unmounted for rack use or in its own floor console — two-channel stereo model (352-2).

APPLICATIONS: Identical playback functions as 351 recorder/reproducer — the playback-only function reduces cost, eliminates accidental erasure of valuable tapes — lower cost, without sacrificing performance, makes it ideal for: broadcasting and recording industry, commercial background music for businesses and industry, dance studios, education, etc.

MODEL 354 . . . a monophonic and stereophonic recorder/reproducer available unmounted, in floor console or portable — records and reproduces two-track stereo with simplified electronics and controls.

APPLICATIONS: Has same applications as Model 351-2 — two-channel electronics in Model 354 are on one panel, occupy the same space as a single-channel panel, thus reducing space and weight, providing easier operation and control. Ideal for stations considering FM Multiplex stereo in future, permitting use as monophonic recorder now, stereophonic in future.

In 1953, the series 350 was introduced as a lower cost alternative to the Model 300. Utilizing a lighter, smaller, somewhat less robust and simplified version of the 300 transport, such as a hysteresis-synchronous tape drive motor with a direct-drive capstan which eliminated the troublesome capstan drive rubber tire, this transport essentially established the mechanical design standard on which nearly all of the subsequent Ampex professional 3-motor machines were based.

Like most Ampex recorders, the 350 was also available as a portable version for recording in the field, wherein the transport and electronics were mounted in individual transit cases. The 300 was also available as a similar portable unit, but required two persons to carry the transport assembly. Most 350s were sold to radio stations, educational institutions, and lower-end recording studios, primarily due to their lower cost, and relatively large numbers of these machines still exist.

The 350 record/reproduce electronics, a pentode/triode design using octal-based tubes, point-to-point wiring, and a separate outboard tube-rectified power supply unit for each electronics assembly or channel, are considered by many enthusiasts to be the best sounding units ever made by Ampex. The separate power supply should be considered as a definite asset, as it provides significant electrical isolation between channels. However, these units employed a shock-mounted and selected 6SJ7 pentode as the first gain stage in the reproduce section, and these tubes were extremely prone to noise and microphonics.

For this reason, many users may prefer the 351-series electronics introduced in 1958,



Classic Ampex machines of the vacuum tube era

which used miniature triodes (12AX7s, 12AT7s, and 12AU7s, all Telefunken as installed at the factory!), tube rectification, printed circuitry, and have more of a "triode sound". However, 351-series machines do not employ the outboard power supply design approach; the power supply is integral to the electronics. The 350 and 351-series electronics each have their sonic strengths and weaknesses; if you can, try to audition both and draw your own conclusions.

The really adventuresome experimenters will want to design and build their own tube record/reproduce electronics, perhaps modeled after Ampex's best efforts. One day, I intend to do just this.

For the serious amateur recording enthusiast, the 1/4-inch stereo 2-track 350 or 351-series recorders are recommended. Replacement parts are still fairly common for these units if you know where to look, and these machines are of extremely robust design and construction, and easy to work on as well. These recorders are absolutely gorgeous sounding when properly set up and aligned.

Ampex professional machines were designed for demanding 24 hour a day continuous operation in broadcast or professional recording service. They are workhorses in the strictest sense of the word, and set the stage for the legendary Ampex reputation for quality and reliability. For home use, they should last nearly forever.

Drive motor and brake assembly rebuilding services are available, as is tape head relapping if the heads in your machine are not too far gone. Be warned that replacement new old stock Ampex heads are now hard to come by and expensive.



One Channel of Model 351 Electronics



Rear View of Model 350 Electronics



Rear View of Model 351 Electronics

Record/reproduce electronic parts are all fairly standard and readily available, and many possibilities exist for modifying and improving the sonics of these units, such as the usual parts upgrades, improved power supplies and the like, but I'll leave that up to you.

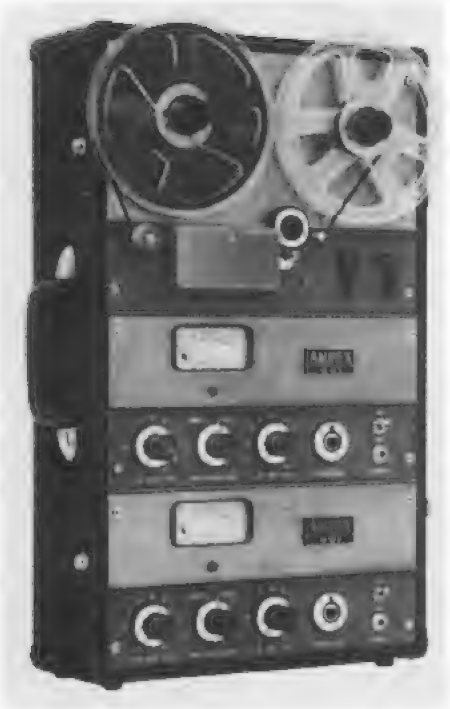
Around the same time that Ampex introduced the 351-series units, the stereo 2-track Model 354 was brought to market. This machine used the 350 style transport with an electronics package incorporating two of the 351-series electronics within a single enclosure with an internal shared power supply, in an effort to reduce the size for console mounting. Tiny VU meters, poorly ventilated hot-running electronics, and a notoriously unreliable record/reproduce slide selector switch which is no longer available, make three good reasons to avoid these machines, and more importantly, the sonics of the 354 are not on par with the 350 or 351-series equipment.

Early 351 and 354 record/reproduce electronics units used phenolic printed circuit boards, which held up very poorly. I find it surprising that Ampex resorted to the use of this material, usually seen in low-end consumer electronics products. Try to find the electronics which incorporate the later glass-epoxy boards which were essentially trouble-free, and save yourself a lot of grief downstream.

Over the years, Ampex manufactured many versions of truly portable professional single-motor machines with 7 inch reel capacity, designed largely for high quality recording in the field, such as the venerable 600-series and the PR-10 (Portable Recorder) series. Although the tube versions of these units are also capable of superb sonics, their transport mechanisms age poorly, and replacement parts are now scarce. Avoid them unless you are certain that the machine you are looking at has been well-maintained and is in good working order.

By the mid-1960s, Ampex began gradually phasing-out the vacuum tube recorders in favor of the solid-state units that the recording industry wanted. The AG-300 and AG-350 (for Audio General) were introduced as the transistorized successors to the 300 and 351-series tube machines. Featuring a dressed-up 300 or 350-style transport, and solid-state electronics, they were the evil-sounding versions of their tube predecessors.

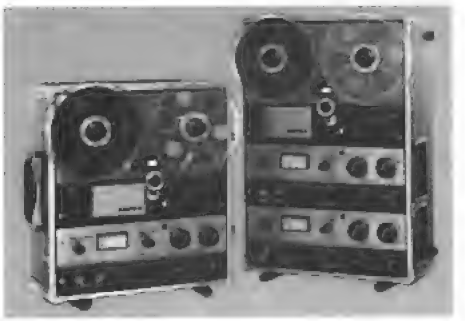
They were discontinued in late 1966, and



601-2



PR-10



AG-600 and AG-600-2

AMPEX

Portable Recorders



ATR-700

replaced in early 1967 with the much improved AG-440 series of product, which ran successively through the early 1980's as the AG-440, AG-440B, and AG-440C units, until Ampex was forced, due to severe competitive price pressure, to resort to offshore-manufactured equipment beginning with the ATR-series recorders. The AG-440C was the last domestically manufactured Ampex audio machine to roll down the assembly line. I believe the AG-440s have one of the best transport designs Ampex ever used. A significantly more robust version of the 350-series transport, 440-series machines feature automatic tape lifters and, in my judgement, the most attractive styling Ampexes' industrial designers ever came up with.

Actually, the AG-440 series recorders sound surprisingly good, considering their transistorized electronics. I run a stereo 2-track AG-440B-2 and a mono full-track AG-440C, in addition to my console-mounted 300C-2 stereo 2-track and 351-2 and 602-2 portable stereo 2-track tube machines. I find that the AG-440s have a very full-bodied sound given their silicon-based design, although some of that solid-state coarseness is apparent upon critical listening. 440-series machines are still very common and easy to get running, and were built in numerous configurations, so you may wish to consider one of these units as well. However, like myself, I'm sure most of you are hung up on getting the old tube machines, so.....

Over the years, Ampex also made a number of machines aimed primarily for the consumer market. Generally speaking, these ranged in quality from fairly good to atrocious, so you would do well to avoid them.

And the best Ampex audio recorder ever made? Most enthusiasts agree that it was the Model MR-70 (Mastering Recorder), introduced in 1964, and manufactured in very limited quantities. I seem to remember reading somewhere that only 70 or so of these fine machines were actually built. An expensive tube design employing extensive mu-metal shielding, metal film resistors, film capacitors, low-noise nuvistors in the front-end of the reproduce electronics section, and a modified version of the 300-series transport, the MR-70 was probably condemned to fail from it's inception. It was brought to market just as Scully was introducing their solid-state model 280, and most recording engineers of the day simply couldn't wait to get rid of the noisy, troublesome, microphonic tube gear used in their studios. Remember, these guys did it for a living, and like anyone else, wanted their jobs to be as easy and nuisance-free as possible.

Unfortunately for us, sonic considerations were and still are almost always of secondary importance in the recording industry.

Internationally, Ampex was the undisputed leader in professional audio tape recording well up to the mid-1960's, and for many years the name was literally synonymous with the technology.

Companies such as Magnecord, Fairchild, Presto, Rangertone, and other manufacturers of professional recording equipment came and went, largely due to their inability to overcome quality, performance, or customer support issues, which were Ampex strengths. Ampex only really began experiencing serious competition in the mid-60's from Scully with their introduction of the model 280, the first high quality solid-state professional studio audio recorder. From that point on, Ampex slowly began losing market share to Scully, Studer-Revox, Otari, and others.



AMPEX

Late-Model Solid State Professional Audio Tape Recorders



AG-440C-2
(late 70s–early 80s)

ATR-100

When you find the Ampex of your dreams, you absolutely must get the original Ampex technical manual for your machine, which are still available from the sources indicated below. Carefully set the reel tensions, head alignment and azimuth adjustments, clean and demagnetize everything in the tape path, lubricate the capstan and/or drive motor, and verify that the electronics are in good working order. Select a brand and grade of recording tape to use, purchase 7.5 and 15 ips NAB or IEC alignment tapes, and align the electronics to Ampex specifications.

Whether tube or solid-state, these machines really come alive at 15 ips. The tape head structure and design, another Ampex hallmark, the so-called "heart of the Ampex" in their early 1950's advertising efforts, and so critical to high quality, distortion-free, wideband magnetic recording, was really optimized for a tape speed of 15 ips. If you want to experience what real stereophonic reproduction sounds like, forget about Audioquests, Mobile Fidelitys, and other audiophile-grade recordings. Make your own. Beg or borrow master tapes and studio out-takes from recording engineer friends. If anyone out there can help, I would love to score an analog master copy of one of Garrison Keilor's "Prairie Home Companion" radio shows, for playback through my system.

We homebrew our own audio reproduction systems; perhaps it is now time for us to begin a revolution in high quality analog vacuum tube homebrew tape recording as well. Our Japanese friends have been doing this for many years now, and you'll never have any shortage of amateur or semi-professional musicians eager to be recorded.

With a pair of good quality, properly positioned microphones feeding straight into the 600 ohm balanced "MIC" inputs of a 351-2 stereo 2-track, and a reel of Ampex Grandmaster 456 recording tape ripping along at 15 ips, you will make recordings with such incredible depth and spatial perspective, clarity, naturalness, and low distortion, that you will probably hear for the first time what stereophonic sound reproduction is truly capable of. Prerecorded tapes and LPs have so many generations between the master tape and you, along with the deleterious sonic effects of signal processing such as gain limiting and compression, etc., that so much information intrinsic to the original musical performance is stripped away that we never get to hear.

When your Ampex is played back through a pair of single-ended directly-heated triode amplifiers with zero feedback and a nice pair of horns, you will be experiencing a totally new meaning to the well-worn phrase, "high-fidelity". And from analog tape recording equipment that was largely perfected before the dawn of the Space Age!

AMPEX Resources

The following sources are recommended for obtaining service, replacement parts, technical manuals, and alignment tapes, as Ampex is no longer supporting their now-discontinued audio product line:

AMPEX Mailing List online FTP Archive

ftp.soundpractices.com
UserID — Ampex
Password—guest

Mr. Vern Sauer
TSI/Technical Services, Inc.
P.O. Box 765
Arlington Heights, IL. 60006
Phone: (847) 392-2958

A genuinely nice guy with a veritable wealth of knowlege about virtually every Ampex audio recorder ever built, Vern is a former employee of Ampex and has serviced these units since the early 1950's. An excellent source for spare parts, service, and technical manuals. Highly recommended, but please don't waste his valuable time with trivial questions about these machines.

(continued on page 44)

If you've ever cried at the end of a great album, conducted the Vienna Philharmonic from your sofa, varied the speed of your driving to match the pace of what's on the radio, or simply sat on the floor playing records and occasionally laughing out loud with no one else around, then you know what heights recorded music can reach. But if those moments don't occur as often as they should—if you find yourself just hearing the sound instead of the music—we'll be all too happy to help.

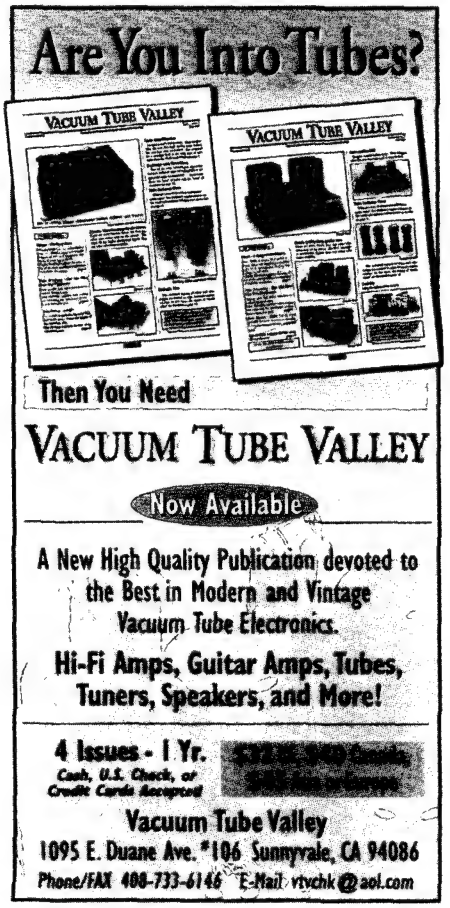
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(continued from page 24)

Sprague Magnetics
12806 Bradley Avenue
Sylmar, CA. 91342
Phone: (818) 364-1800

When Ampex stopped supporting their audio products in the early 1990's, Sprague acquired all of their remaining spares inventory, engineering documentation, etc., and has reintroduced some parts which Ampex had discontinued. Consider them for parts for mostly the AG-440 series and ATR-series machines, tape heads, technical manuals, etc., but be prepared to spend some bucks.

VIF International
P.O. Box 1555
Mountain View, CA. 94042
Phone: (408) 739-9740

High quality after-market pinch roller assemblies.

IEM
350 No. Eric Drive
Palatine, Il. 60067
Phone: (708) 358-4622

Replacement tape heads and offers a good relapping service.

JRF Magnetic Sciences
249 Kennedy Road
Greendell, N.J. 07839
Phone: (201) 579-5773

Replacement and reconditioned tape heads, and also offers a relapping service.

Premium Parts & Electronics Company
Route 3, Highway 59
Whitewater, WI. 53190
Phone: (414) 473-2151

Replacement belts and idler wheels for Ampex portable professional machines, such the 600-series and the PR-10. Also offers an idler wheel rebuilding service, and stocks some replacement tape drive parts for the Ampex consumer machines. They cannot, however, rebuild the rubber-tired capstan-flywheel assembly used on the 300-series recorders.

Mr. Jay McKnight
Magnetic Reference Laboratories
229 Polaris Avenue
Suite 4
Mountain View, CA. 94043
Phone: (415) 965-8187

High quality alignment tapes, in NAB, IEC, AES, and CCIR equalization. Mr. McKnight is a former long-time employee of Ampex.



Homebrewer of the month

Ed Billeci of Portland, OR

When you step into audio craftsman Ed Billeci's listening room, you know you are in the presence of a maniac homebrewer playing in the far outer ionosphere of Planet Audio, out where there are no maps and inspiration is the only guidepost.

Ed's system has the unique charm that only one-of-a-kind and built with love audio gear has, but this set-up is so *extreme* that it stands apart from the crowd. Very few searchers are hard-bitten enough to stretch out quite so far in pursuit of their personal audio vision.

Really, only a handful of audio hobbyists progress to the point where they would even know they wanted something like this—let alone wanting it bad enough to make it a reality? No doubt about it, Ed Billeci is a homebrewer of the first order.

The centerpiece of this breathtaking installation is a pair of monster 212 single-ended amplifiers, constructed on three industrial-strength chassis per side: one each for the HV supply, LV supply, and audio circuitry. Every audio tube is provided with its own separate supply chassis and, to give an idea of the over-the-top beef factor of Ed's mighty 212, the mono PS for each WE 437A input tube weighs 75 pounds! The HV supplies are 130 lbs. a side!

Ed says that he got hooked on the rare, ancient, and huge 212 triode about five years ago when he needed a tube amp to drive some hoggish two-panel Acoustats. A prototype 212 SE amp he built as an experiment impressed him to the point where he decided to undertake this no-limits project, so he must have been pretty damn impressed!

The eye-popping 212 amps in the pictures took the man over three years to build, including two years selecting and collecting parts. The final push to get the amp "on the air" required six months of what the builder called "intensive" application of time and labor.

Due to the level of build quality he just had to have, poor Ed was forced to blow out a big chunk of his vintage audio collection in order to finance construction, but so what?— a whole warehouse full of junky old-fashioned tube amps doesn't even equal one channel of this phenomenal 212 amplifier! Real excellence never comes cheap.

Each chassis is fashioned from aerospace aluminum I-beams heliarc welded into frames that hold a total of 30 individual polished brass framed subassemblies. The intent of the packaging design is to have the ultimate triode amp breadboard. The modular construction streamlines the process of continual experimentation and refinement by swapping out subassemblies.

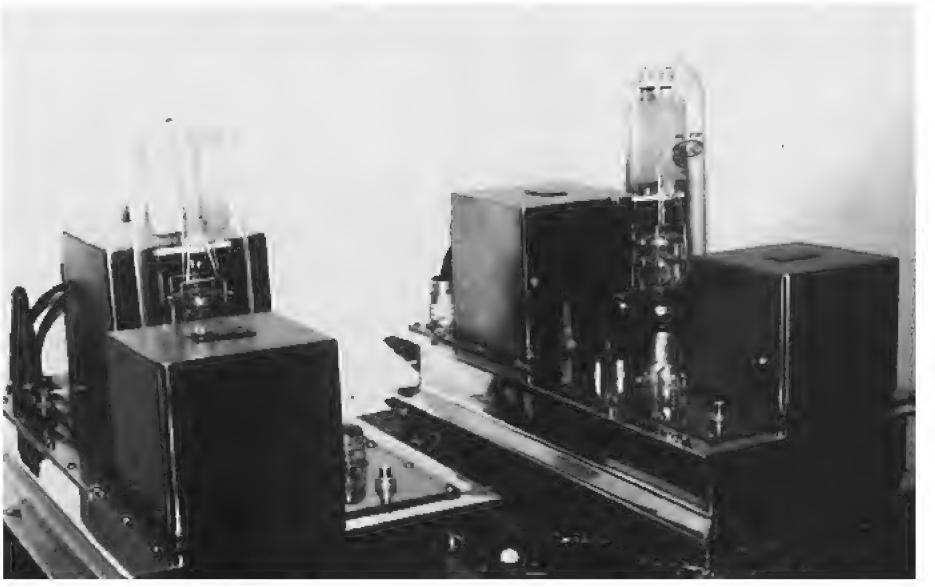
One would guess that the other intention of the builder's packaging concept was to blow the minds of all who gaze upon the creation.The silvery aluminum bar stock, golden brass top plates, and shiny brass hardware speak pure elegance to the eye.

If you got to look underside, what you would see is a large collection of transformers and chokes. According to Ed, there are 32 pieces of iron in these babies, counting the four Bartolucci audio transformers.Twenty-four of the transformers are in polished steel cans mounted above the chassis.

In addition to lots of chokes, all power supplies utilize mercury vapor rectifiers, 866s on the HV and 816s on the low voltage supplies. Weighing in at 700 pounds, including the custom-made aluminum and polished marble racks, these three-box 212 mono amps are not very well suited for portable applications. Ed did drag the amps up to the recent VSAC show in Washington State where he handily swept away first prize in the homebrew amp craftsmanship competition.

Although these 212s put out 50 watts easy, Ed likes to think of the amplifiers as "twenty-watters with lots and lots of headroom," although they can crank out a lot more juice on the bench. Since he converted from electrostats to horns a few years ago, twenty watts is enough, thank you.

The current loudspeaker setup, subject to continual change, is a TAD 2001 compression driver on an RCA 300 Hz fifteen-cell horn. Ed prefers the sound of the fiber material used in these three-row RCA horns over what he was getting from the usual metal multicells. A modified JBL adapter mounts the TAD to the RCAs, originally supplied with hardware for screw mount drivers instead of bolt-ons.



Audio circuitry for Ed Billeci's three-chassis monoblock WE 212 amps

The bass cabinet uses a *Western Electric* 728B 12" in a modified horn salvaged from a discarded Altec A-7 cabinet and the driver is loaded by a rear-firing bandpass ported system on the low end. Ed made his own foil inductors from copper flahing and polypropylene film..He rolled the stuff up then took it to a shop to have it cut into slices. Signal cable is custom 21 ga. and 23 ga. silver wire, made from ingots at a local refinery., insulated with fiber tubing, sonically superior Ed says, except in the HV lines where he uses teflon tubing over the fiber for safety's sake.

Amazingly, Ed is happily married, living proof that a big horn system and marriage are not entirely exclusive. Ed says his wife, Chi, is the most patient woman in the world. Well, that's good because Ed is now working with John Camille on a high frequency AC filament supply for the 212s, since DC doesn't sound as good as AC. Hey Ed, looks like you'll need another shelf on that rack!

Check out Ed's homebrewer page!
http://www.teleport.com/~tube

Phono setup includes an idler-wheel turntable built from a recycled broadcast turntable and a mono Denon DL-102 cartridge on a 50s vintage 16" Gray professional transcription arm. The tonearm is mounted on a separate 20 pound copper base which can be moved around for set-up adjustments. Spin those mono LPs and 78s, dude!



The φ42
A Phono Preamp for "WOT" and Whatnot



by Diego Nardi
Audio Note Italia

Promises are promises. When, at the end of my article about the "WOT" line preamp in *SP #10*, I said "A true phono stage for use with the WOT I will design when I have time," I was meaning it. Here's a design for a phono stand-alone unit which may partner either the WOT or virtually any other existing tube or solid-state line preamp or integrated amplifier and which, given a competent line stage, may even readily become a one-chassis complete preamp.

It is the latest development of my split-RIAA Phono circuit, of which I have already given you an anticipation in the above mentioned article. I have been working on it for the last two years and I think it has now reached a very satisfactory level.

GENERAL CONSIDERATIONS

I reckon the Phono preamplifier is one of the most interesting and challenging topics an audio gear designer may ever decide to face. It is a deadly cocktail of massive gain, accurate frequency response shaping, low noise, and vast headroom demands. Designing a power amp, even a relatively sophisticated one, looks nothing but a primary school test of arithmetic by comparison, and this is probably why you don't see too many Phono circuits in audio magazines.

The lower the operating level, the more difficult it is getting low coloration AND low or no dynamic compression AND high resolution at the same time.

1. DESIGN CHOICES.THE GAIN

First of all, it is required to set a gain target. The RIAA spec sets the 0dB reference of the de-emphasis curve at 1 kHz, therefore it is standard practice to consider the gain at 1 kHz as the "nominal" gain, while at the low end of the curve (which is specified at 30 Hz, below which the response should more or less flatten out;(see RIAA spec for further details) the output level shall be +18.61 dB.

The actual inherent gain of the circuit will then turn out to be the 1 kHz nominal gain, plus 18.61 dB, plus the loss of the equalizing network.

The necessary gain at 1 kHz depends on the input level, i.e. the cartridge output voltage, and the sensitivity of the rest of the chain.

The output voltage of cartridges is expressed by most manufacturers at 1 kHz, 5cm/s, and we may use this value as a "nominal" one. You all know that today's cartridges may be broadly divided into two categories: "traditional" moving coils, and all the others including moving magnets, variable reluctance and a few moving coils of the so-called "hi-output" variety.

The nominal output of moving coils may vary between, say, .05mV and .4mV (-84 up to -66 dBm), yeah that's desperately low. The "others" show outputs nearly always falling between 1.5mV and 7mV (-55 to -41 dBm), with the great majority between 2.5 and 5mV.

Let's now pretend we have a 5mV magnetic screwed to our beloved tone arm, a WOT preamp or something with a similar gain (a bit more than 20dB into 100k ohms) and a power amp demanding 0dBm into 100k ohms to put out full power. Question: how much amplification do we need in the Phono preamp?

It is reasonable to assume a few more things:

a) The program material is likely to contain peaks about 10dB above the nominal level, and we don't want these to overdrive the power amp;

b) The program material might VERY SELDOM contain peaks up to 20dB in excess of the nominal level; we accept to take the risk these will clip the power amp but we DON'T want them to clip the preamp; the preamplification must have tons of leeway under the most tragic circumstances;

c) We don't want to be forced to turn the volume full up to entirely exploit the power amp with "average" records. We want at least 20dB volume leeway.

The above leads to a required level, at preamp input, of about -10dBm (line gain 20dB, average amp drive -10dBm, amp clipping 0dBm therefore amp leeway 10dB). Our moving magnet cartridge puts out 5mV, that's about -44dBm.Therefore, minimum required gain 34dB.

Hey, folks, that's already 52.61dB at 30 Hz, PLUS the EQ loss. Serious amplification indeed!

Yet this is the very least required for a Phono stage, and, in commercial products, a Phono nominal gain in the 34-38dB range has become a de facto standard. Only problem is, this sort of gain does not leave any margin and will give weak sound if the cartridge only puts out 2mV and/or the power amp is only 2V sensitive and/or this 2V sensitivity is referred to just...three watts (the typical tragedy of the usual super-uninspired, oversimplified 2-stage single ended lice so fashionable today...).

If there's one thing that I really hate, that's "insensitive" systems. Therefore, the target I chose was higher gain at no sacrifice of dynamic margin. The nominal gain of this preamp is 42dB, and you need to throw HALF A VOLT RMS to approach saturation. 42dB above 500mV makes for about 63V RMS -180V p/p- and this is more or less what the circuit can put out at less than 5%THD.

This preamp is therefore NOT of the MC direct plug-in variety. The reason why I think this is a loser strategy is explained in the next paragraph. Nonetheless, the gain is high enough to rock and roll your system even with the most uninspired "not-too-high-output" 1mV coils—and get a quiet background from this level up.

As regards the dynamic headroom, I chose to keep it so high in order to get super-super low distortion at ordinary operating levels, but avoiding, at the same time, to have insufficient drive signals anywhere in the circuit. In other words, while high gain is helpful in keeping the signal far above thermal noise and low level "dirt", large dynamic margin is an insurance against dynamic compression and non-linearity. This is not to get academic nice-spec results, but for very positive sonic purposes —explosive dynamics, smooth distortion-less presentation.

Proper component choice also contributes to this, but you get your money's worth of high-quality components only if the design you start from is itself capable of worth-while performance. Even the very best component, be it active or passive, is wasted money if the equipment it is used in is not up to it. A shrewd design with inexpensive components, cleverly used, will most easily outperform a modest, trivial design even if the latter is made with high quality parts costing several times as much.

Sorry for all you Silver Transformer WE-91 Loftin-Whiters: a side valve engine is always a side valve engine—regardless of magnesium cylinder blocks or titanium rods.

2. DESIGN CHOICES. MC OR NOT MC? THIS IS THE QUESTION...

What to do if what we are trying to pick up any music from is not a "vigorous" 5mV magnetic, but a shy .1mV moving coil? Let's go back to the previous example and pretend for a moment (just pretend, and just for a moment!) we try and add a further, flat response active stage in front of our MM preamp. .1mV is ANOTHER 34dB below 5mV. Nice, isn't it? In order to get the same level as before, it takes a 34dB preamp working between -78dBm and -44dBm.

It's IMPOSSIBLE to make it with no feedback AND decent S/N ratio—let alone sound resolution. If you have just one miserable microvolt equivalent thermal noise at the input—that's nearly -118dBm, and you might already need to be taken to a psychiatric hospital after you've been looking for a device that quiet—you're STILL getting an accordingly miserable 40dB S/N ratio, or, to put it another way, you're getting a heck of a noise out.

There's just one way to (apparently) get rid of this noise: F-E-E-D-B-A-C-K. Design a nice strong 74dB stage and stick 40dB feedback around it. With this foxy strategy, the input stage of this fantastic preamp of yours will be driven by just one microvolt out of the hundred your bold cartridge is so generously delivering, as the other ninety-nine are being, well, fed back.

With one microvolt you won't even convince a flea choir to sing "Wimoweh". Forget about driving any audio amplifying device.

The only thing that can successfully handle the signal from MC cartridges is a TRANSFORMER. If properly designed and made, it will introduce much less crap into the signal than any electronic means, and will provide excellent impedance matching. There's no point in wasting money on an expensive MC cartridge if you're going to mix mud with its signal.

By the way, beware of cheap MCs, most of them are over-resonant, over-distorted, are hard on records and sound compressed and metallic. If you're on a budget you'll be better off with a good magnetic. Try out the recent Audio Note IQ series, for example. I may look partial but I don't demand you take my word on this—try one yourself. These cartridges offer a much better combination of dynamics, low surface noise, and low overall distortion than any MC/transformer combination at comparable price. I myself have gone for an IQ II after ten years of MCs.

3. DESIGN CHOICES. EQUALIZING.

There are two main solutions to the problem of RIAA equalization: there can either be a passive network between two stages, typically where there is an RC coupling, or there amy be a selective feedback loop. They are called respectively—and quite intuitively—"PASSIVE RIAA" and "ACTIVE RIAA".

From the commercial manufacturers' standpoint, the "active" solution offers the important advantage that the shape of the response suffers less of the sample to sample variability of the active devices: this is why the great majority of preamp designers have gone for it in commercial products.

Fine for them, not for us. Obtaining RIAA equalization by selective feedback requires applying a feedback factor increasing nearly 36dB from 30Hz to 15kHz, whatever the starting value (i.e. the value at 30Hz). Not only do you get the loss of resolution and dynamic compression that go together with high feedback, but this effect is also frequency dependent.

I reckon the consequences this fact has on music reproduction are truly devastating. I'm not surprised so many people definitely took to CD and threw away all LPs in the Eighties, claiming they were hearing lots of distortion from LPs; in some respect, they were probably right. A great many of them had always been listening to LPs through active RIAA preamps.

Well, let's be sincere: active RIAAs were certainly not the ONLY cause for this. Over-resonant over-compressed cartridges, big under-resolving over-distorted amplifiers, horrible no-dynamic over-coloured speakers ALSO played their role in LP misappreciation—and still sadly do in modern "hi-end," look at how many spend megabucks in expensive D/A converters...

Nonetheless, LP playback through feedback EQ preamps remains a most frustrating experience regardless of the quality of the rest of the system. So, as far as I am concerned, active EQ can be thrown into the sewer—finest brown rat food—where it rightfully belongs.

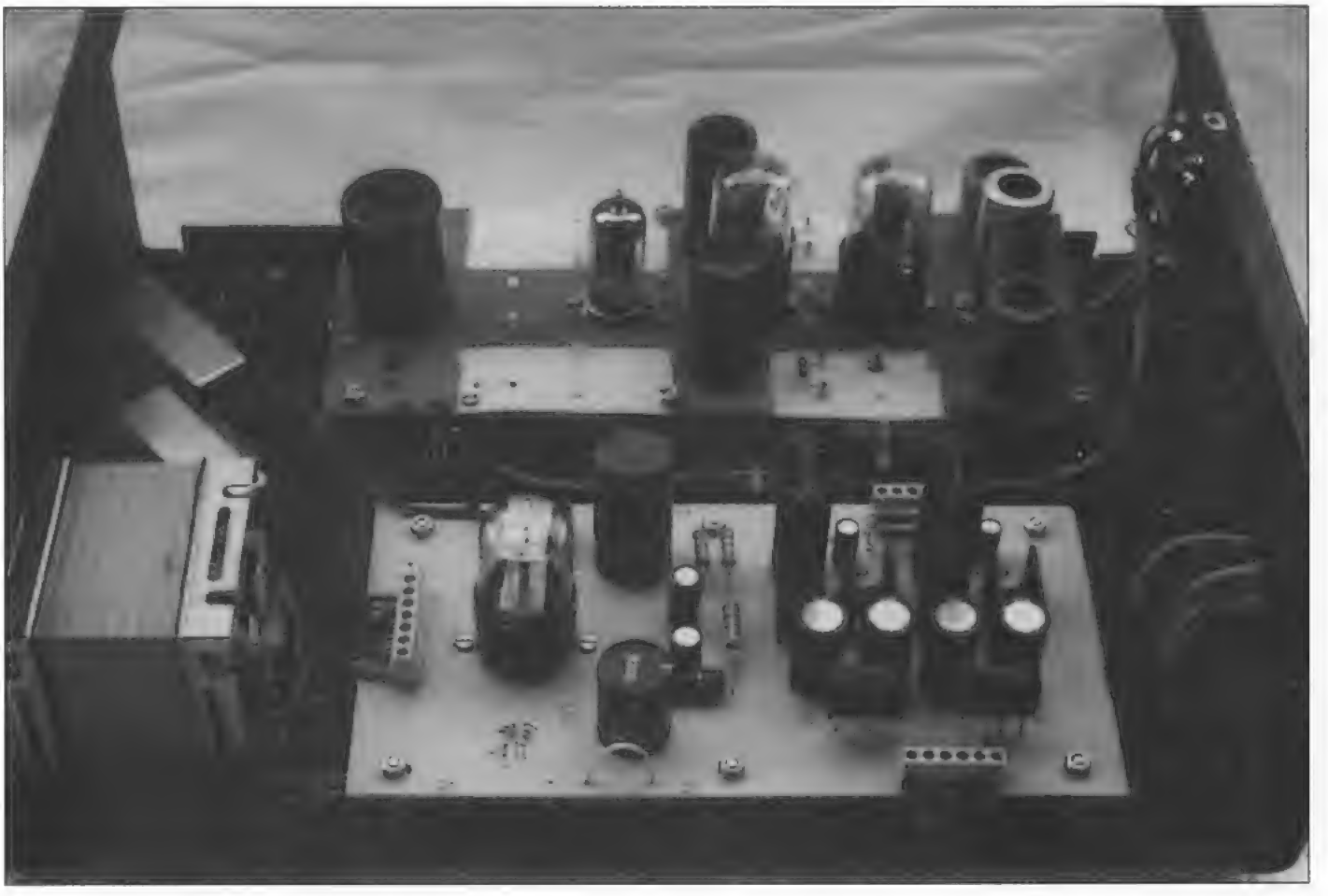
Attempts of making semi-passive EQs (usually two time constants in feedback, the third one passive) yield semi-results. Brown rat food with some sugar on. Not very worth wasting any time on, really.

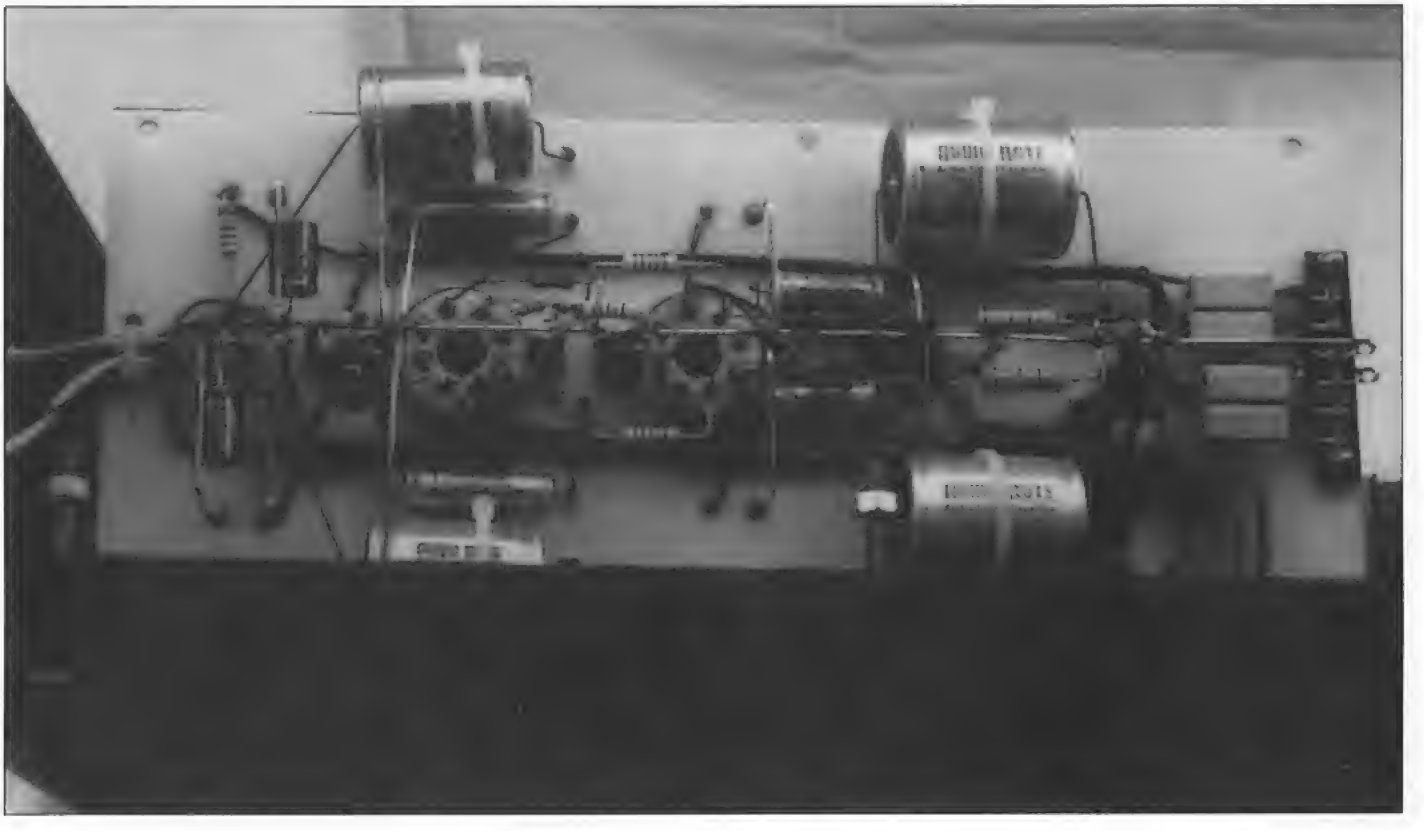
Entirely passive equalization is not an "alternative". It is the ONLY possible solution if you are even marginally concerned with sound quality.

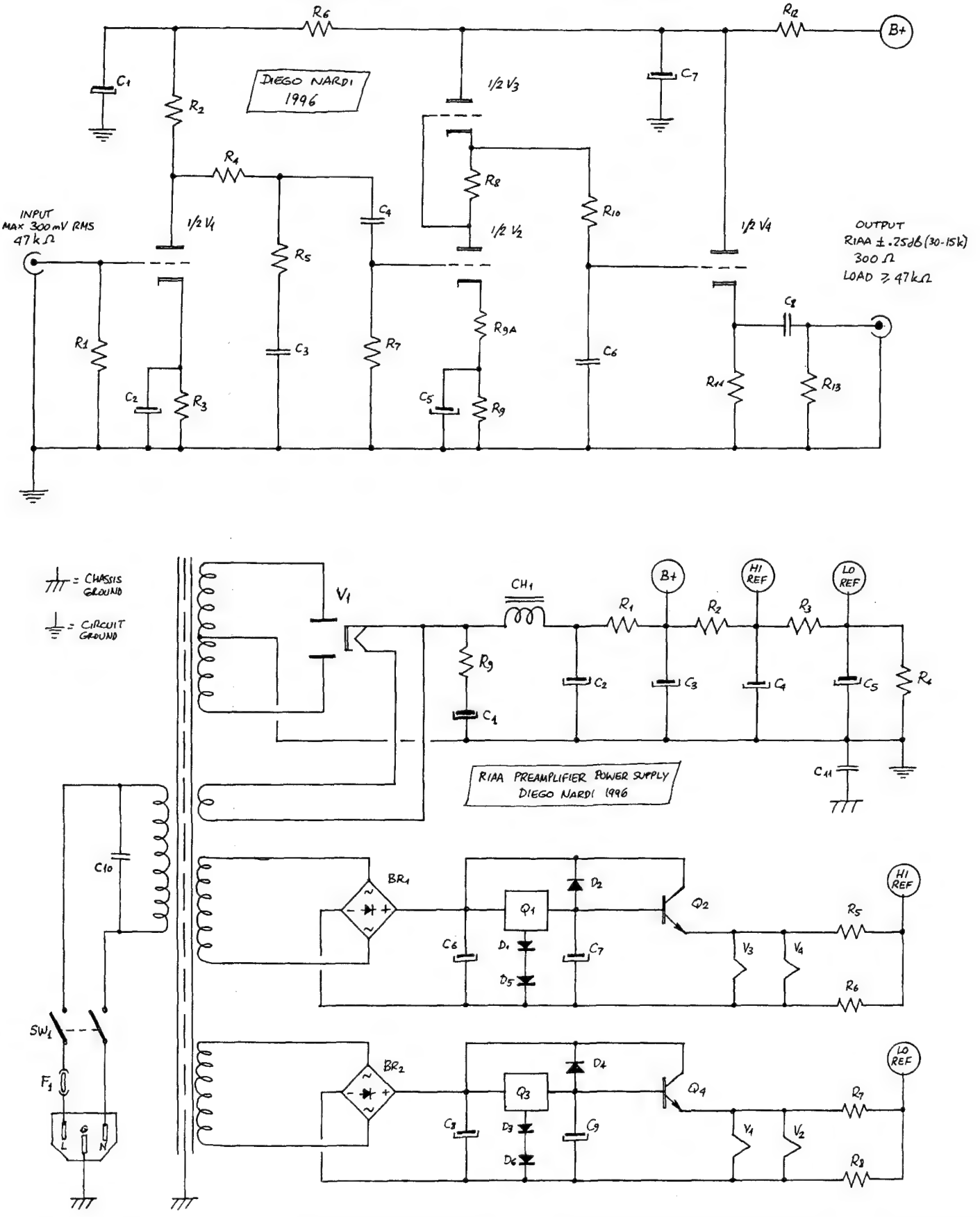
As I have anticipated, passive RIAA is generally obtained by placing a suitable network, implementing all the three required time constants (for further details, see again RIAA spec), plus, if desired, the fourth one provided for by the RIAA/IEC (basically a subsonic filter with -3dB point

Above–
General Layout of preamp

Below –
Audio circuit module featuring super-compact point-to-point construction technique






3-STAGE RIAA PREAMPLIFIER - AUDIO CIRCUIT (ONE CHANNEL SHOWN)
DIEGO NARDI 1996
INPUT
MAX 300mV RMS
47kΩ
OUTPUT
RIAA ±.75dB (30-15k)
300Ω
LOAD ≥ 47kΩ
B+
1/2 V1
1/2 V2
1/2 V3
1/2 V4
= CHASSIS GROUND
= CIRCUIT GROUND
RIAA PREAMPLIFIER POWER SUPPLY
DIEGO NARDI 1996
HI REF
LO REF
L
G
N

AUDIO CIRCUIT

Position	Standard		SL	
R1	47k		47k	○
R2	220k 1W		100k 1W	
R3	1k		680R	
R4	392k		150k	○
R5	27k 4		15k	○
R6, R12	1k 5W	●	1k 5W	●
R7	820k		470k	○
R8	2k 2		2k 2	
R9	not used		2k 2	
R9A	2k 2		330 R	❑
R10	75k		47k	○
R11	47k 2W	❑	47k 2W	❑
R13	2M2	❑	2M2	❑
C1	47uF 400V		47uF 400V	
C2	100uF 6.3V	■	220uF 6.3V	■
C3	.012uF 400V	▼	.022uF 630V	▲
C4	.022uF 400V	▼	.22uF 630V	▲
C5	not used		100uF 6.3V	■
C6	820pF 630V	▼	1000pF 630V	▲
C7	220uF 400V		220uF 400V	
C8	.33uF 400V	▼	.33uF 630V	▲
V1	12AX7/ECC83/7025		12AY7/6072	
V2,V3	6SL7GT		6SL7GT	
V4	6SN7GT		5687	

Notes:

Unmarked resistors are metal film, 1/4W except where noted.

○ = tantalum film 1/2W

● = wirewound, vitrified or ceramic base

❑ = low noise carbon film, 1/4W except where noted

Unmarked capacitors are electrolytic

■ = Black Gate "F" type

▼ = Audio Note paper in oil, aluminium foil

▲ = Audio Note paper in oil, copper foil

POWER SUPPLY

R1	2k2 5W	C7, C9	470uF 16V
R2, R3	33k 2W	C10	.1uF 250V
R4	1k5 2W	C11	.01uF 1000V
R5, R6,		CH1	25H@30mA
R7, R8	100R 2W	V1	6X5GT
R9	470R 5W	D1, D2, D3	
C1	47uF 400V	D4, D5, D6	IN4003
C2	220uF 400V	BR1, BR2	80V@4A
C3	470uF 400V	Q1, Q3	7806
C4	10uF 350V	Q2, Q4	BDV 65
C5	10uF 63V	SW1	DPDT switch
C6, C8	4700uF 16V	F1	T315mA for 220-240V, T630mA for 110-120V

Notes:

Unmarked resistors are carbon film.

● = wirewound ceramic base

★ = class X2 surge suppressor cap. Example: RIFA type PME 271 M. On the SL version, R1 is replaced by another choke, same as CH1. C11 may need to be replaced with a short—depends on how the mains grounds of the other equipment is connected.

at 20Hz) between two RC-coupled stages.

These three time constants are virtually always obtained by means of resistors and capacitors—no inductors. Inductors are not used not certainly because they don't work (they would, and very well at that), but mainly because of the inordinate inductance values necessary to get the required time constants with manageable overall impedance values. The only recent example of LCR RIAA Phono stage that I know of is the Audio Note M10...(of course next morning you'll go and buy one, won't you?)

Back to our tried and true RC EQ network. There's a big problem in designing in the "traditional" way, i.e. with the whole curve obtained with a single network. If the equalization is to be really "passive", it should have negligible effect on the inherent gain of the stage driving it, i.e. the input impedance of the network should be much higher than the output impedance of the active stage across the whole audio band. A network to comply with this has a very unpleasant side effect that the designer simply can't avoid: high insertion loss. On balance, a network having limited insertion loss would overload its driver stage at the higher frequencies. There's no real way out and all the designer can do is settle for a compromise, typically ending up with some 6dB attenuation at the beginning of the curve, and easily more than that.

If you privilege constant loading, you'll get smooth sound, but dynamics will inevitably be somewhat sacrificed. If instead you prefer low insertion loss, you'll get a dynamic but somewhat uneven and aggressive sonic presentation, and you might find that some dynamic compression is better tolerated after all.

A countermeasure that effectively mitigates this problem consists in splitting the RIAA network into two separate ones, and this is precisely what I did.

There has been another split-RIAA preamp described in SP, it was J.C. Morrison's "Siren Song" in #3, although, apart from this basic idea, it doesn't share any other solution with the φ42, even the order in which the time constants are placed in the circuit is different.

With this technique, I was able to limit the insertion loss of the first network to only 2.5dB, while the second one is placed in a direct coupling and its passband insertion loss is practically negligible.

The load variation on the first stage is such that the max. inherent gain variation is about .5dB between 50Hz and 2kHz, where the RIAA drops about 18dB.

ACTUAL CIRCUIT DESCRIPTION

I'm actually proposing two versions of this preamp. They differ in circuit parameters, and choice of both tubes and passive components; consequently, COST.

Both sound clear and intensely contrasted, with strong and neat dynamics and almost total lack of strain; the SL (Special Luxury) version however features better focus and a finer grain, tauter sound overall. Neither version sounds "mellow" and syrupy however. If you're looking for romantic, adulterated sound, don't go for this preamp as this is not what I mean by "lack of strain". I do not want any of my designs to have any sonic signature themselves; what I try to get is equipment that sounds different with every record. The φ42 is very much this way.

Sorry for this brief introduction that is not relevant to circuit description directly. It is meant to help you decide to read on or turn the page...

If you want to fully appreciate the above characteristics, however, I have to warn you that you MUST follow my recommendations regarding component choice as strictly as possible, and you MUST NOT mix up elements of the standard version with elements of the SL. The two versions have independently undergone a very painstaking fine tuning procedure and, if you want to re-start from the beginning by modifying anything, you can do it at your own risk but, as Herb Reichert says, it'll be your own preamp design, not mine. I won't accept any responsibility about the sound you might end up with. Don't forget that both circuit parameters and component choice do contribute to the final result.

The first stage is made of a high-mu, high impedance triode in a conventional plate follower arrangement, driving the network which implements the first "step" of the de-emphasis curve: R4-R5-C3 form a reactive divider which is substantially in parallel with the load resistor. C4 is chosen to complete the action of the divider in proximity of the low-frequency flattening-out pole (the 3,180 microsecond time constant), and start a subsonic filtering rolloff around 30Hz.

Please note that the low-end frequency characteristic of the SL is somewhere in the middle between RIAA and RIAA/IEC specs, i.e. it is subsonic filtered but slightly less than RIAA/IEC. The standard is very close to RIAA/IEC.

The standard and SL have different input triodes (12AX7/7025 on standard, 12AY7/6072 on SL) with matched loads and EQ networks.

The second stage of both versions is made of a 6SL7, SRPP connected and DC coupled, via the 75 microsecond network, to the cathode follower output which is based on a 6SN7 in the standard, a 5687 in the SL.

The 6SL7 stages of the standard and SL differ in cathode degeneration, DC operating point and EQ network. Apart from the split RIAA, which is not very conventional, the circuit is therefore quite conventional and its main feature, which you can't tell from the circuit diagram alone, is the care taken in the choice of loading/operating conditions of every part of the circuit.

The input impedance is 47k ohms. The great majority of hi-output cartridges and MC matching transformers will work fine into this load. Input capacitance is about 120pF plus wiring capacitance in the standard version, 60pF in SL.

Resist the temptation of building those wicked 1980s style DIP-switched "load matching" R-C banks. This stuff is as good as active RIAAs (sewer rats'll love it).

The output impedance is low, about 300 ohms in standard and 200 ohms in SL, but the output stage is not designed for very low loading. Optimum load impedance is 47k ohms or higher—25k ohms is tolerated. Overloading the output will narrow the available dynamic headroom and, although this may seem quite immaterial, you run the risk of getting a "tired" sound. It should be noted that no sensible line stage has less than 47k input impedance, so this is no limitation in fact.

THE POWER SUPPLY

Power supplies are always very critical to overall performance, and this case is no exception. The specific demands of this circuit are quite different from those in the WOT: there I had a single stage working at a rather low voltage, which I wanted to be able to modulate relatively significant amounts of current; here there are instead three stages, all of them running into high controlled impedances and modulating modest currents. As a consequence, very much smaller values of capacitance, compared to those in the WOT, are sufficient to provide a "quasi battery" operation of the HT supply. It is, on the other hand, vitally important to obtain a clean, low ripple HT source to feed the circuit from, and that's why I went for a twin-pi preliminary filtering, which is then split into two separate decoupling rails, one for each channel.

The rectifier is again a 6X5GT, connected in the same "pseudo-direct heating" way already used in the WOT.

The resistor in series with the filter input capacitor has the sole purpose of limiting the current surge through the rectifier at switch-on, which would otherwise slightly exceed the peak current rating for 2-3 seconds about 15 seconds after switch-on. This may occasionally result in some sputtering which, although not destructive, is unpleasant to see. When the power supply has settled, about one minute later, the rectifier runs under very relaxed conditions, with a 60mA repetitive peak current per plate and a 50% overall duty cycle.

It is absolutely necessary to provide two completely independent heater supplies, in order to ensure correct heater to cathode voltages within all tubes. I decided not to make dual supplies, as I did in the WOT, partly because they should have been +/-3V instead of +/-6 (6SL7 can't light up on 12V), therefore difficult to regulate, and partly because they would have taken too much room and would have complicated the power transformer too much. By the way, the latter is a proprietary, custom unit, specifically designed for this preamp. You don't find it in parts catalogs by any supplier.

The heater regulators are transistor buffered 7806s for maximum noise rejection. Both supplies have "artificial" center taps connected to an auxiliary HT divider supplying the relevant reference voltages. All of these measures contribute to avoiding any heater-induced noise.

It is sad to notice how underestimated the problem of correct heater arrangement has been, and still is. There are a lot of preamps in the market, even very expensive ones, that have "structural" noise problems due to incorrectly organized heater supplies. A very typical mistake is connecting the two sections of the same twin triode as an SRPP stage or as a direct-coupled voltage amplifier/cathode follower pair. In this way you will almost invariably get "whistling" or "hissing" type parasitics, regardless of the potential of the common heater. This is due partly to the cathode/heater capacitance and leakage current, unduly and uncontrollably connecting together two cathodes supposed to be independent (electrical coupling) and partly by the two triodes ping-ponging any mechanical vibration between each other (mechanical coupling).

It wouldn't be that difficult to use the two triodes within each envelope as the same section of the two channels, instead of as the two sections of the same channel. If the two co-tenant triodes are made to work at the same potential,they practically stop fighting with each other, because the grid-to-grid capacitance is fractions of a picofarad, and if there is little or no potential difference across the K1/H/K2 impedance, little or no current will flow between the two cathodes! In addition, if two cathodes working at largely different potentials are heated by independent heaters, you can separate the latters' power supplies thus making it possible to set correct heater/cathode voltages in each section...simple, isn't it? But no manufacturer seems to care, really...and the user has to live with his whistles.

Reacting with the decision of not using SRPP or cathode followers or direct couplings would be an ultimately stupid way of sidestepping the problem in my view.

COMPONENT CHOICE

After having spent long, sleepless nights studying and experimenting circuit solutions and parameters to give the least distorted and most convincing sonic results, it would be utterly foolish to spoil all this hard work with an incorrect component choice. I repeat once again: NO component, be it a tube, a capacitor or a transformer, of whatever finest quality, will ever turn a toad into a prince: you need an inherently high performance design FIRST. But then components must be competent with it if you are to exploit its possibilities.

A very critical thing here is capacitors, especially those in the circuit. If you want to avoid the risk of bitter disappointment after building this preamp, you need to follow my advice and go for Audio Note's paper-oils. Standard version is intended for being equipped with the alu-foil type, SL instead requires the copper foils.

If you say these caps are madly expensive, I will answer I also think so, but you're stuck with using them if you really want lack of distortion and dynamics, and at

Audio Note they know this full well; so all that's left for you to do, whatever you are planning to build (not only this preamp), is resign. Can't get Audio Note caps? No problem, please feel free to contact me personally and I will be glad to help you on this.

The cathode bypass caps are also critical. The φ42 was developed with, and specified for, Black Gate F, an affordable version for your joy and delight. Since the complete set of cathode BGs costs less than a single alu-foil paper oil, it is totally senseless to resort to normal electrolytics, with, maybe, some fancy horrible sounding French style set of bypasses across them...

Can't find the required values in Black Gate F? Please read above.

Filter and decoupling electrolytics are all normal aluminium types in both versions. These also must NOT be bypassed in any way for any reason. As I have already written and will keep on repeating, bypassed electrolytics sound like cat piss and are to be avoided like AIDS.

Please note that all capacitors, and very especially Black Gates, demand some run-in time for their dielectrics to mechanically and chemically settle. Remember there is a varying electrical field, and consequently mechanical forces, between the foils of a capacitor. Therefore, you should never attempt critical listening of any brand new piece of electronics, or of a used piece of electronics after a cap change if the cap under test is brand new—this also applies to tubes, transformers, coils and speaker drivers—or you will easily end up with grossly wrong conclusions!

Resistors in the standard version are all normal 1% metal films except for a few low noise carbons, and some, largely derated, wire wounds in decouplings. The SL features some tantalum films in critical spots.

Now to the delicate topic of chassis signal wiring. Input wiring must, first of all, be as short as possible in order not to uselessly increase the input capacitance; output run may be longer, within reason, depending on chassis shape and size.

If you decide to go for Audio Note wiring, as I not surprisingly do, recommended cable types are AN-S for standard, AN-V for SL. It is not cost effective to equip the SL with the more expensive AN-Vx; with the same extra money you get more sonic benefit by upgrading all cathode caps to Black Gate FK or by using a silver foil for C4. How much the extra expense would actually be obviously depends on the length of your cable run.

The AN interconnects are themselves balanced. To use them as internal wires in this preamp, connect them as follows: all input and output RCA sockets must be insulated from chassis; on both input and output cables, use the red internal conductor as "hot", the white one as ground return; on input cable, connect the copper screen at circuit ground end; on output cable, instead, separately connect the screens at RCA connector collars.

CONSTRUCTION

This preamp is best built on two separate modules, but NOT in separate chassis. The first module should support the heater supplies, the HT rectifier and the first two HT filter caps; the other one will then support the circuit with all HT decouplings. This eases handling and rationalizes wiring. I recommend the first module to be a true PCB with the heater supply routes etched on (transistors ain't very suitable for hardwiring). The best material is the good ol' smelly Bakelite if you can still find some.

The second module is best point-to-point hardwired with bus grounding—avoid star grounding. An alternative to bus grounding consists in using another PC board. Etch a ground plane of suitable size on it, then hardwire the circuit making all grounds to the ground plane, which will then be connected to the power supply ground through a single path.

Be neat, don't extend component legs—you won't need to do it if your layout is correct—and make provision for all solderings to have a sound mechanical support. (On the pictured board, there are a couple of points in which I had to join component legs "on air"; that was a "last minute" mod, don't take this technician's shortcut as an example!)

Diego Nardi FREE BONUS 6SN7 SRPP Line Preamp

Parts List

R1–R2	1k 1/2W
R3	470R 1/4W
R4	1M 1/4W
R5	33k 1W
R6	1k 5W wirewound

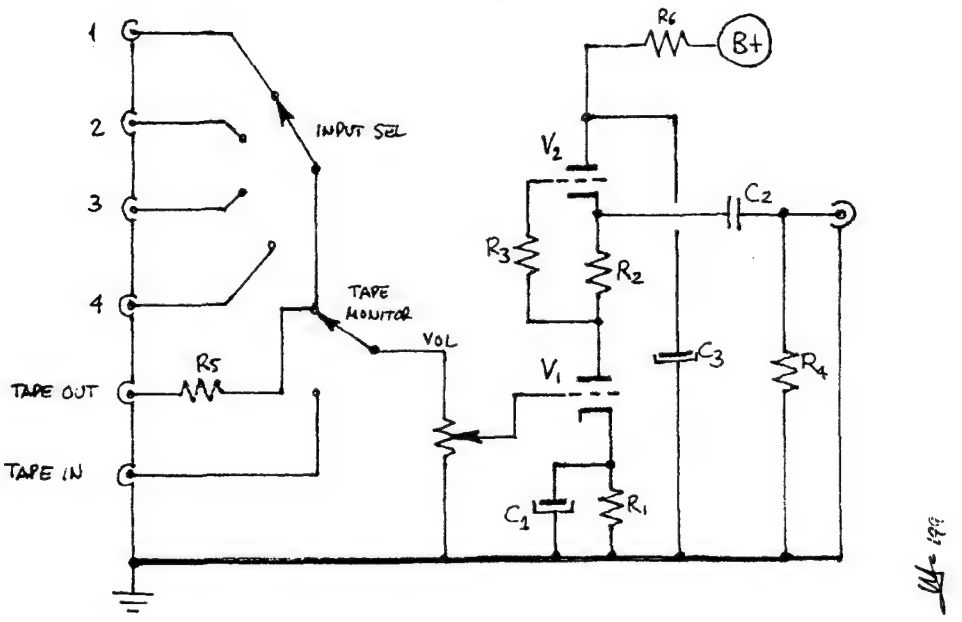
All other resistors carbon type

C1	220 mF/16V electrolytic or Black Gate type
C2	0.47 – 1 mF 400V Audio Note paper/oil (copper or alu foil)
C3	220 mF 400V electrolytic

Volume	50k or 100k B Taper
V1–V2	6SN7 GT/GTA/GTB

Power supply

Refer to phono schematic. B+ is taken from the positive terminal of C2.V1 heated by LOREF supply,V2 heated by HIREF supply.



There's no need for many soldering stand-offs in this circuit, most joints can be made directly at socket pins, decoupling cap pins and at ground bus with the exception of very few points; the use of tagstrips or other similar devices can, and should, be reduced to a strict minimum. This can be done at no sacrifice of order and reliability.

BONUS LINE PREAMP!

Aha. This is for you, Mr. Igot Nomoney. You have just made a list of the parts you need to build yourself a φ42, and you discovered you are ALMOST going to run out of money? And, by chance, you ALSO need a line preamp?

No problem. Here's a suggestion for a super-simple, very good sounding line stage you can very readily stick to your α42 using its in-board power supply.

All you have to add is a pair of 6SN7s, a volume pot and a few other components. The 6SN7s, arranged in a classic SRPP mode, form an excellent line amp, yielding a gain of about 23dB into 100k ohms with around 2k5 output impedance and a max out level of over 60V RMS across a quarter megahertz bandwidth. No, it doesn't sound quite as good as a nice new WOT, but it's still better than nearly everything you can find at audio stores regardless of price, and it's cheap, WOT the hell!

It takes both heater and HT power from the existing supply and you can also run "backwards", i.e. first you build yourself the power supply and line amp, then you add the φ42 Phono board. The 6SN7 SRPP line stage is in fact an old favorite of mine, and I have proposed it several times in the Italian press, the last time was in the September 1995 issue of *Costruire HiFi* magazine (the first one dates back to 1991). It always receives great acclaim after people try it out, and an earlier version of the φ42 was in fact published in the same magazine as a Phono stage to go with the SRPP line! Therefore, the two are tried and true and go great together. Have fun!!!

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Design and Easy Calculation of a Regulated Power Supply for a 300B Stereo Amplifier

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The job of the power supply in a push-pull amplifier is facilitated by a symmetrical arrangement of the output devices that eliminates residual hum by cancellation. Moreover, if the push-pull amplifier operates in true Class A the current flow is constant and the power supply voltage does not fluctuate with the rhythms of audio modulation. Class A push-pull amplifiers present a relatively simple challenge from the standpoint of power supply requirements.

It is a completely different story with the single-ended triode amplifiers currently in fashion. In these amps, the residual hum is applied to the output transformer through the internal resistance of the tube (see Fig.1). If we presume that the residual hum is 100 mV, a hum voltage on the order of 4.5 mV will appear at the output of the amplifier. Of course, this is not tolerable, especially when high efficiency loudspeakers are employed.

The classical cure is to add more filter capacitance, which can work well, or to add more inductance in the choke, which could be bad if it raises the internal impedance of the power supply. The consideration of internal supply impedance leads us to the second point of the argument, by far the most important.

Let us look at the operation of a single ended output stage when driven almost to the point of clipping by a large sinusoidal signal. The positive half of the signal applied to the grid increases the current in the tube and creates a condition of maximum power dissipation in the supply. Then the negative signal causes the current to decrease until it is nearly cut off and at this moment the power dissipation is again at maximum.

Where does the power come from? Obviously, the power is taken from the energy stored in the primary inductance of the output transformer.

$$Q = 1/2 \; LI^2$$

There is an analogy in the work of the coil ignition of an automobile. In order to do a good job, the output transformer must have a substantial inductance, a well-known fact, but the power supply must also be able to reload the primary inductance effectively.

In your car, no problem. The battery is husky and the charging current gushes forth. In an amplifier, it is easy to be far from the mark. For instance, a reservoir capacitor of 100 microfarads will have an impedance of 80 ohms at 20 Hz. That is *not* negligible. (see Fig.2, the measured impedance of a 100 microfarad capacitor).

The regulated power supply can cure both of these problems, by decreasing the hum below the thermal noise level and providing an internal impedance lower than 1 ohm at all reproducible audio frequencies.

Principle of the Regulated Supply

In our regulated supply, the rectification and filtering are achieved in the classical way but the high voltage current is supplied to the amplifier through the regulator tubes, called the *ballast*. (see Fig 3).

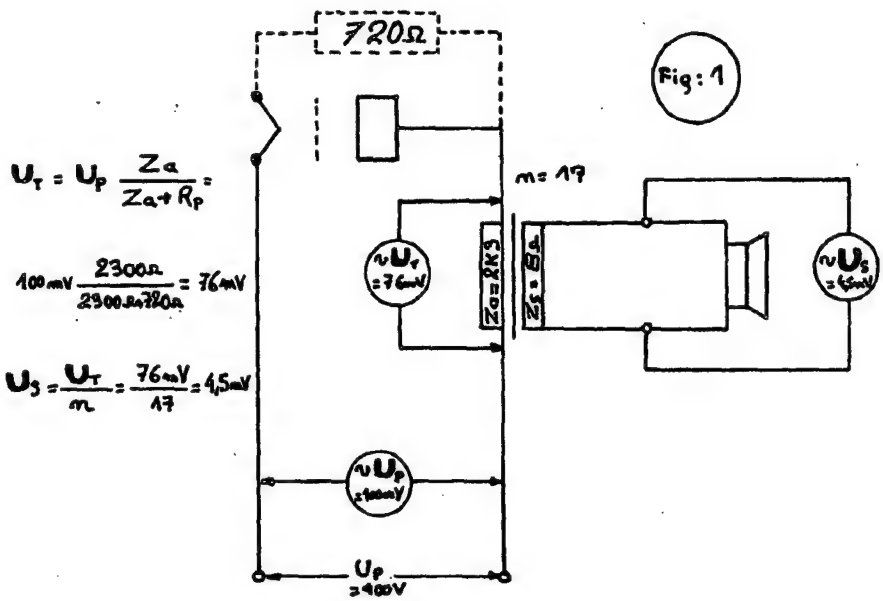
The ballast in the regulator under discussion consists of several low plate resistance triodes (6080, 6AS7, 6336) connected in parallel. The triode grids are controlled by a differential amplifier which compares the instantaneous value of the high voltage to a reference voltage provided by zener diodes or a voltage regulator tube (85A2, 0A2, 0B2, etc..

From moment to moment, the variations of the high voltage supply are corrected through the action of the regulator. Since nothing is perfect, there is always a residual hum and some voltage variation dependent on the load. Let us examine how we might keep these inevitable failings as negligible as possible.

Design of a 400V—250mA Supply

Figure 4 gives the diagram of a simplified regulator minus the various artful devices which we will add to achieve the desired quality. The parts shown in the block diagram of Figure 3 are replaced by electronic components:

The ballast tube T1 is the 6080 dual triode, a tube type specifically designed for



this application.

The T2 tube, EF 184, is a sharp cut-off pentode normally used as an RF amplifier, but also perfect for the job here.

Resistors R2 and R3 feed the screen grid of the pentode and provide the current for the zener diode voltage reference source. R1 is the load for the pentode.

Potentiometer P1 acts as a voltage divider to supply a part of the high voltage to be compared with the reference voltage.

Let us move on to a practical exercise, a regulated power supply to power a stereo 300B amplifier with a required voltage of 400V and a current delivery of 250 mA.

Calculation of the Ballast (T_1)

Figure 5 shows the basic system with one triode section of the dual triode 6080 illustrated. Since these tubes have a control grid with a tight pitch placed very near the cathode, the consequent grid current can be very inconvenient. This is especially a problem with old tubes.

Therefore, it is prudent to maintain the instantaneous voltage of the grid very negative and that prescribes the first limitation: The bias will have to be above –40V. That means that the voltage between plate and cathode will have to be no less than 100V in the worst case, that is to say when the line voltage is decreased by 10%.

The necessary voltage after rectification and filtering, therefore, must be:

$$U_F = U_R + U_{T1} =$$

$$400V + 100V = 500V$$

Now we find that, when the line voltage is increased by 10%, the rectified voltage will reach

$$(500V \times 120\%)/100\% = 600V$$

In this case, the voltage between plate and cathode of the ballast tube will be:

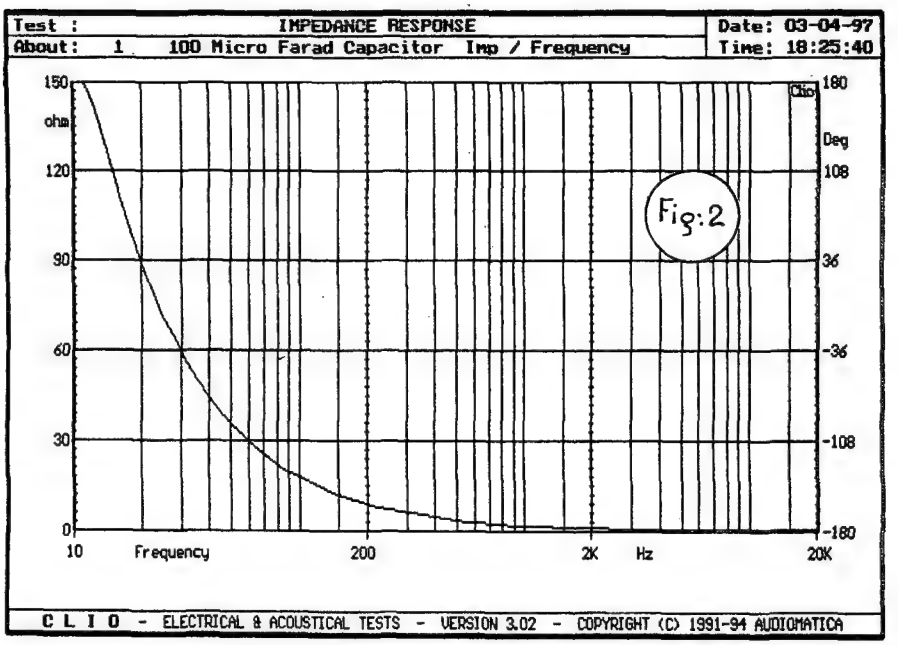
$$600V - 400V = 200V$$

That gives a dissipated power of

$$200V \times 250\ mA = 50W$$

for a current consumption of 250 mA.

We can see immediately that this power requirement, although a rarely seen extreme case, forces us to use several 6080 tubes in parallel because each half of a 6080 can only dissipate 1 W. Two 6080s (4 triode sections) are good for 52W. This is just enough, without any margin of safety.



An improvement to the basic scheme of Fig. 4 consists of fitting a resistor in parallel with the 6080 to handle part of the current (see Fig 5).

The choice of value of this resistor must be made with the 250V plate-cathode voltage limit of the 6080 in mind. A higher voltage can arc over, causing damage to the cathode coating.

Note also that the 300B tubes the supply is powering are quick-heating filamentary types and the 6080 are slow-heating cathode types. Without the parallel resistor R4, the voltage after turn-on across the ballast tube would reach the totally unacceptable value of 600V in the worst case situation of 10% high line voltage.

Since the normal current flow of a pair of 300B tubes is about 150 mA, R4 will have to drop 250V maximum at this rate of current flow.

$$R4 = 250V/150mA = 1k\Omega7$$

The current through the 6080 will be notably decreased and will go down as the line voltage goes up, thereby helping to regulate the power dissipated by the ballast tubes.

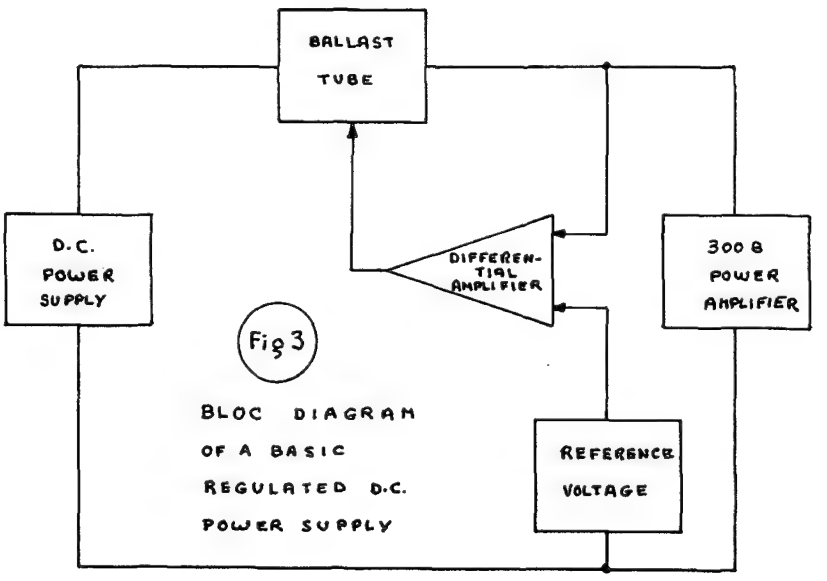
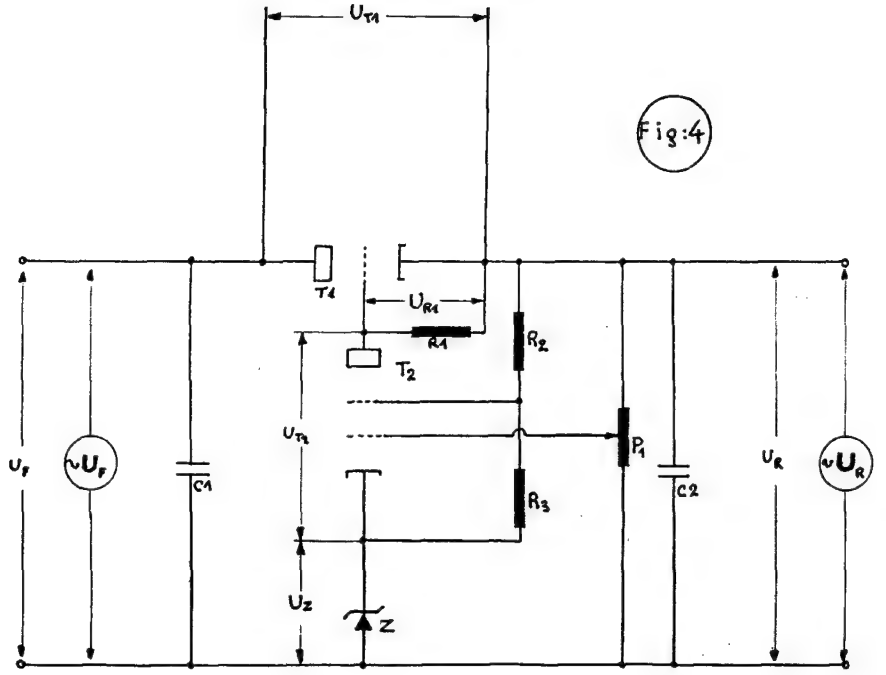
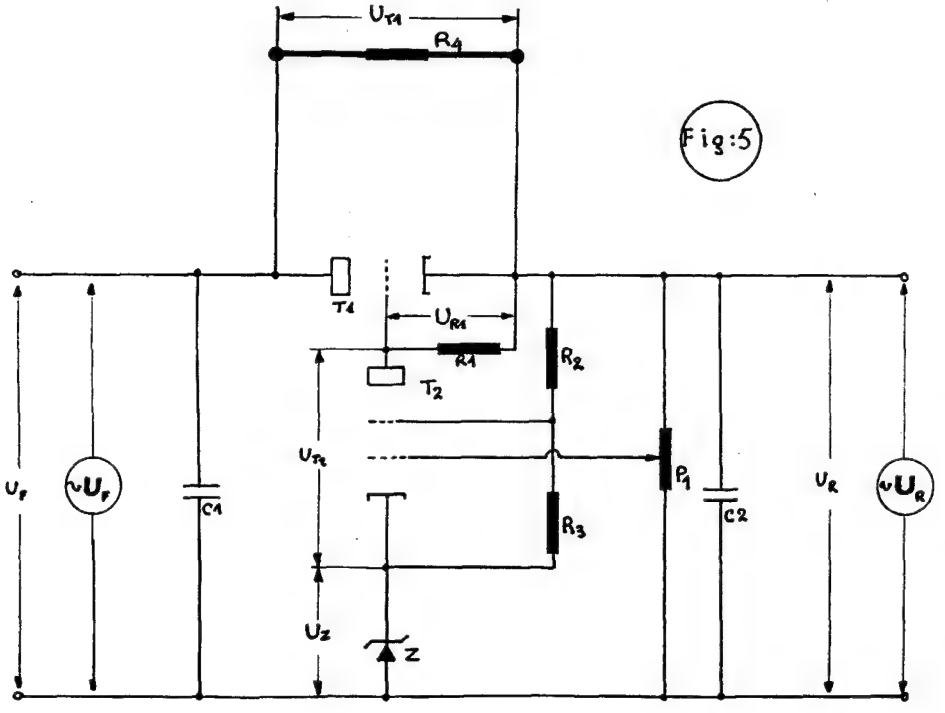


Fig 3

BLOC DIAGRAM OF A BASIC REGULATED D.C. POWER SUPPLY





So for a minimum line voltage (-10%)

$I_{R4} = U_{T1}/R4$

$= 100V/1k\Omega7 = 59mA$

and the dissipated power in the tubes will be

$P_{T1} = 100V \times 191\ mA = 19W1$

for a nominal line voltage.

$U_F = 550V,\ U_{T1} = U_F - U_R =$

$600V - 400V = 150V$

$I_{R4} = U_{T1}/R4$

$= 150V/1k\Omega7 = 88mA$

and the dissipation of the 6080 will be

$P_{T1} = 150V \times 162mA = 21W3$

For the case of maximum line voltage (+10%):

$U_F = 600V,\ U_{T1} = U_T - U_R$

$= 600V - 100V = 200V$

$I_{R4} = U_{T1}/R4$

$= 200V/1k\Omega7 = 117mA$

the current in the 6080 will be

$P_{T1} = 200V \times 133mA = 26W6$

It appears that on the basis of power dissipation alone, one could be content with only one 6080. However, prudence commands to use two tubes for security's sake and for two other reasons.

1—Two tubes improves the regulation from the standpoint of residual hum and lower internal impedance of the power supply.

2—The variation between 6080 tubes is astonishing. It is an idle dream to find two tubes that are matched between sides and between tubes. Therefore, we must also wire in balance resistors in series with the cathode of each tube. The chart in Fig.6, published by SOVTEK gives useful information. For four triode sections in parallel in the absence of precautionary measures, the maximum power handling of each tube is not more than 7W4 and 29W6 for the quartet, thereby erasing our security limit entirely.

Installing 100 ohm series resistors in series with each plate improves the situation such that the power handling becomes

$9W5 \times 4 = 38W$

This arrangement is the second improvement we propose (see Fig.9).

Design of the Differential Amplifier

The transconductance of the EF184 is 15000 micro-mhos in normal use. Here, the transconductance is highly reduced owing to the very low current flowing through the pentode in our special connection. Since the differential amplifier escapes calculation, it will have to be estimated empirically, but we are mainly interested in the gain (and regulation factor) we obtain. Maximum gain will be determined empirically by varying R1 using a 1MΩ potentiometer.

On the other hand, The values of R2, R3, and the Zener reference voltage can be determined by calculation, considering the current through the pentode as negligible and without any practical effect.

Zener Reference Voltage Choice

It is a compromise. The higher the voltage, the more of the potentiometer will be in circuit.

Since $U_R = U_{R1} + U_{T2} + U_2$, the Zener voltage is a compromise between the voltage drop across R1, the voltage between the plate and cathode of T2, and the voltage on the Zener diode. Given the realities of the components that we are using, we have to provide a reasonable operating voltage for the pentode. In view of this requirement, the error voltage applied to the grid of T2 through P1 must be limited to a certain value, even if the efficiency of the regulation is thereby decreased.

What is the voltage on the plate when the power supply is at nominal line voltage? We previously determined that in this condition, the current through the 4 x 6080 would be 162 mA (40.5 mA in each triode) and the voltage between cathode and plate would be 150V.

Referring to the curves of Figure 8, it is easy to determine that the grid voltage should be –70V. therefore, the plate voltage of the EF 184 is

$$U_R - 70V = 400V - 70V = 330V$$

If we consider that it is wise to keep about 200V between plate and cathode on the EF184, we have

$$330V - 200V = 130V$$

for the reference Zener voltage. Since 62V Zener diodes are readily available we can use two in series to obtain

$$U_Z = 62V \times 2 = 124V$$

The values of R2 and R3 will determine the current through the Zeners. It is necessary to be very prudent in this, because zeners definitely don't like heat. The wattage rating given by the manufacturer must be severely derated.

We use B2X 85C diodes and they are specified for 1W3 or about 2.5 W for the two diodes. Taking a factor of 5 as a security coefficient, we would only dissipate 0.5W for the two diodes and 0.25W per diode. For a half-watt dissipation, the current should be

$$P/U_2 = 0.5W/126V = 3mA9$$

$$R_2 + R_3 = U_R\text{-}U_Z/3mA9 = 70K\Omega$$

We can choose to use 2 resistors of 39KΩ each, yielding a power dissipation of 0.22W per diode at 3.5 mA.

Resistance in cathode circuit of each triode separatly, Ω	Number of triodes at parallel operation											
	1		2		4		6		10		over 10	
	I_A mA	P_A W	I_A mA	P_A W	I_A mA	P_A W	I_A mA	P_A W	I_A mA	P_A W	I_A mA	P_A W
0	130	13.0	93	9.3	74	7.4	68	6.8	64	6.4	56	5.6
50	130	13.0	101	10.1	87	8.7	82	8.2	78	7.8	72	7.2
100	130	13.0	106	10.6	95	9.5	90	9.0	87	8.7	82	8.2
150	130	13.0	109	10.9	100	10.0	96	9.6	94	9.4	89	8.9
200	130	13.0	112	11.2	104	10.4	101	10.1	98	9.8	94	9.4
250	130	13.0	114	11.4	107	10.7	104	10.4	101	10.1	99	9.9

I_A — anode current of one triode
P_A — anode dissipation of one triode

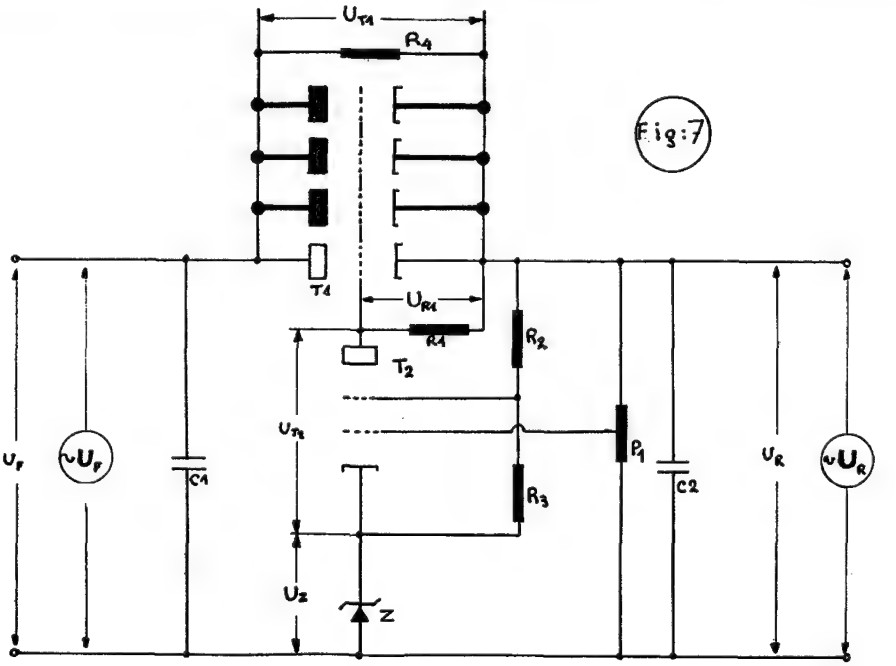
Fig:6 REPRINT FROM SOVTEK 6AS7 DATA SHEET

I believe that modern Zener diodes are better than glow discharge VR tubes in terms of noise and internal impedance. However, it is absolutely necessary to bypass them with a high value capacitor. We use a 100 microfarad electrolytic capacitor (C4) paralleled with a 0.47 polystyrene. This is the third important improvement on the basic circuit of Fig. 4, as pictured in Figure 10. The bypass capacitors eliminate residual hum on the regulated output and should be considered absolutely essential. It is not possible to adequately bypass a glow discharge VR tube because a VR tube and capacitor in parallel has a tendency to provide an excellent generator of sawtooth waves!

Choke Filter Elimination

The above discussion does not address rectifier and filter problems coming upstream of the regulator circuit we describe. A good regulator allows us to forego a choke and use only one capacitor after the rectifier.

The rectified and filtered voltage U_F is wired to Grid #2 of the EF 184 pentode



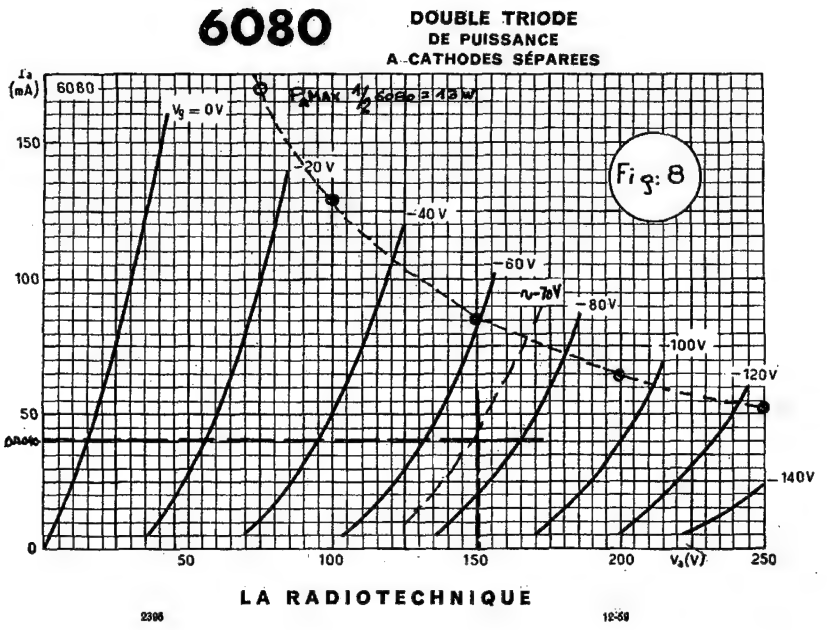


Fig: 8

through C5 and adjustable resistor R5. This capacitor should present a negligible resistance at 100 Hz (120 Hz for the USA) We use a 0.47 for C5. There is no sensible progress in increasing the value. In any case, R5 allows a fine adjustment of the compensation. This is the fourth improvement toward making the best of electronic regulation, shown in Fig 11.

Lastly, there is another simple way to improve the regulation. We install a capacitor C6 between the upper terminal of potentiometer P1 and its moveable contact so that any variations in U_R are conducted directly to the grid of T2. This represents the fifth and last improvement we propose (Fig. 12).

Results

All those efforts to put this regulated supply into place truly pay rewards. The benefits are clearly evident in the measurements, taken in actual conditions of use powering a stereo 300B single-ended amplifier and 2x 6BQ5 in the input stage.The actual current flow is 250mA with the output voltage at 400 V.

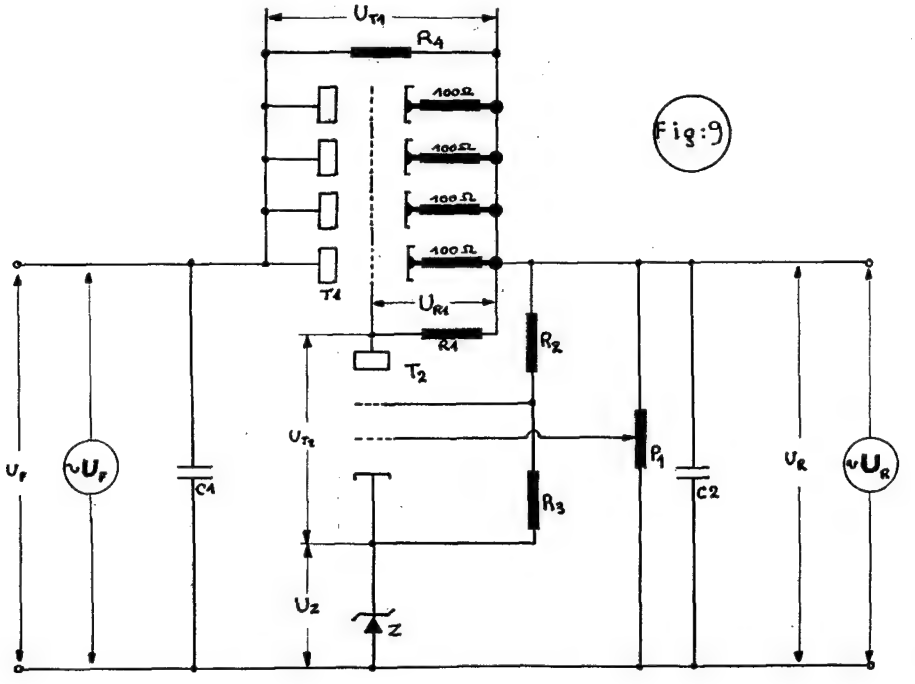


Fig:9

Controversy on R1 Disposition

Some writers have indicated other solutions to power the load resistor of the pentode tube, R1.

1st Variant: The resistor is connected before the regulation on U_F.

In this case, the voltage U_F is always more than U_R, therefore the current is increased through the pentode and, consequently, its transconductance is increased. And, the efficiency factor is increased also.

This is an advantage, but unfortunately, there is the problem of hum which does not exist in the U_R connection.

2nd Variant: The resistor is connected to an increased external voltage source.

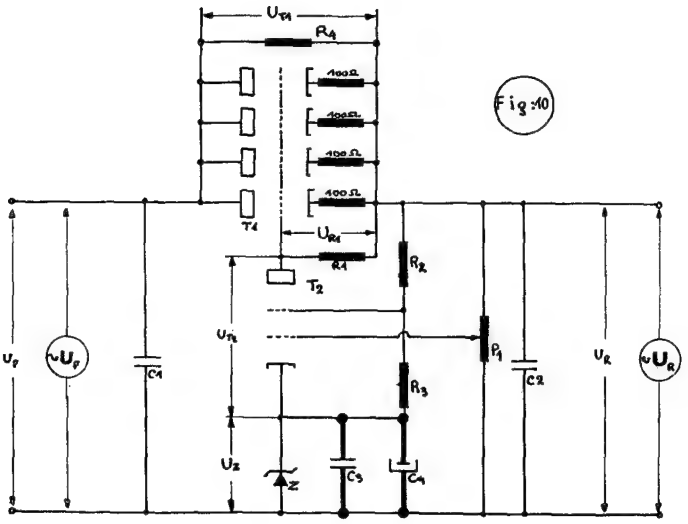
If the auxiliary voltage is very well-filtered, the result is indeed improved. However we have to pay for this improvement with a substantial increase in complexity if the auxiliary supply is not already in place. Therefore, we chose not to adopt that strategy.

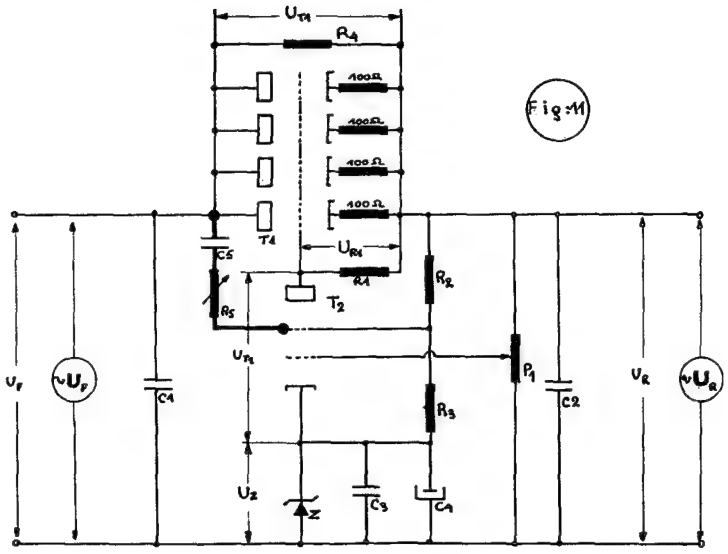
The curve shown in Figure 13 indicates the regulation area. The voltage on the primary of the power transformer is varied with an auto-transformer. The voltage is stable at 400V under line voltage variations between 180V and 250V (and probably more, but 250V is the limit of our auto-transformer). This 20% security zone is very comfortable, even though we may never use it in practice.

Experience shows that when the hum stays lower than 10 mV, the signal to noise ratio of the amplifier is not seriously affected. This hum level becomes evident with a line voltage decrease of about 12%. Taking this as the limit of the regulator, the security zone of the regulator is still quite considerable.

The practical results demonstrate the reliability of the calculations and suggest that the method outlined above would be useful for the design of other power supplies.

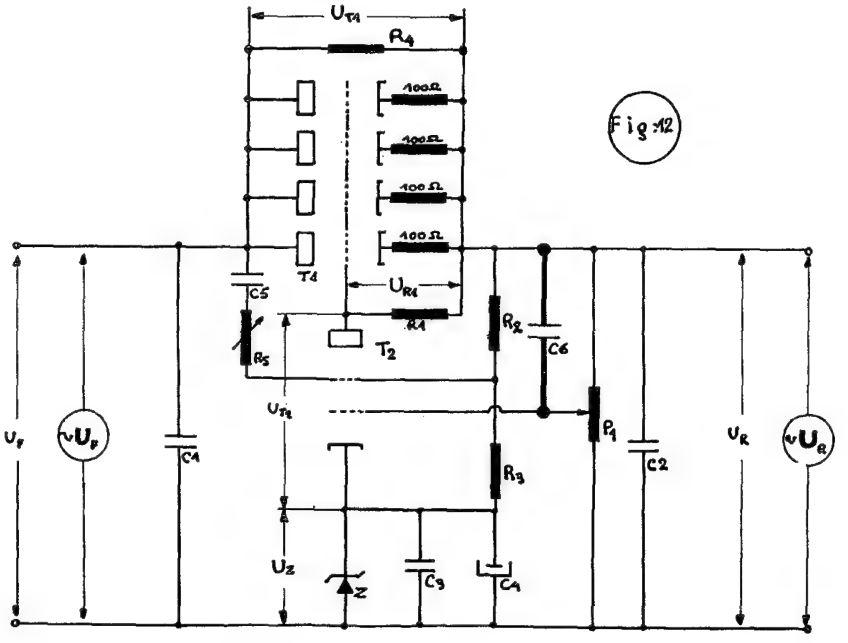
Finally, the measurement of internal impedance as a function of frequency given in Fig. 15 is most pertinent. The

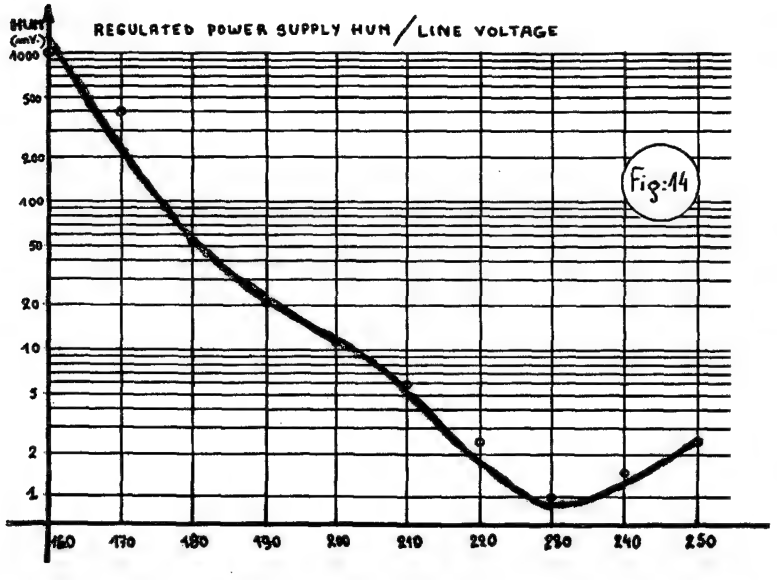


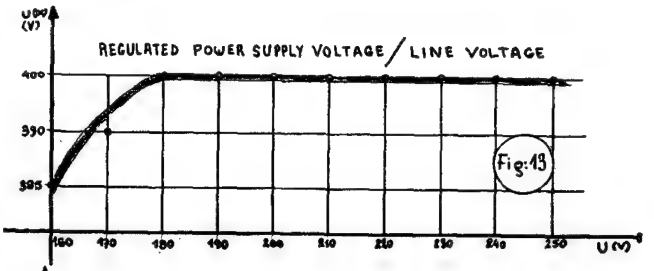


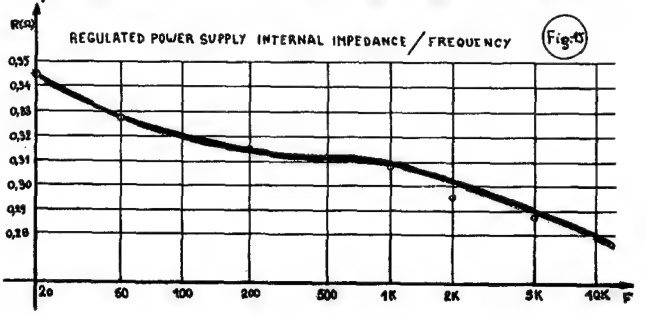
amplifier is driven to maximum power by a sine wave generator between 20 Hz and 10 kHz. The millivoltmeter is connected to U_R through a 100 microfarad capacitor, large enough not to affect the frequency response of the test setup.

At 20 Hz, the internal impedance of the power supply is less than 0.35 ohms. To obtain the same result with a capacitor would require 22,000 microfarads. This demonstrates that a regulated power supply offers a large improvement and at a cost that is practically the same (considering that the filter choke is removed). The result is near perfection.



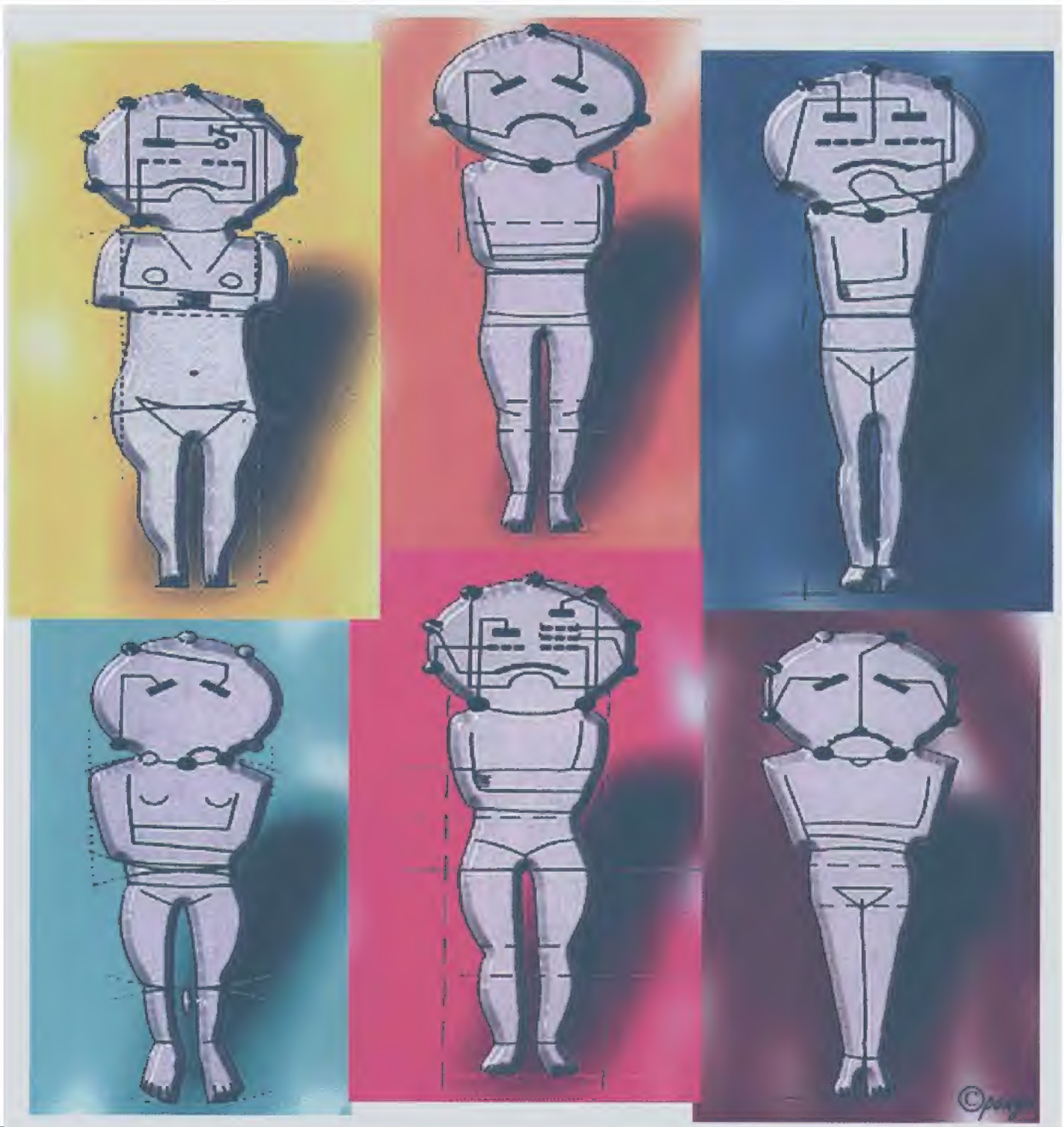






SOUND PRACTICES

THE JOURNAL FOR AUDIO EXPERIMENTERS FIVE DOLLARS



Options and Preferences Issue 15

The B-52

Parallel-fed VV-52B SE with triode-wired 7788 transformer-coupled driver



by Grego Sanguinetti, Sanguinetti Design

A while ago Ron Welborne announced a close out pricing deal on the VV labeled VV52b power triodes. After hearing so much about these tubes, I couldn't help taking advantage of this special offer.

Upon opening the box I immediately fell in love with this tube. Like the 808, 833, and 845 amps I had to build simply because of the looks of the tubes, I was driven to create an amp around the VV52b.

I proceeded with a few primary goals in mind:

1. Elegance by simplicity, i.e. low device count, especially in the signal path.

2. Adequate power for wildly varied tastes in music in my 900 square foot family room.

3. Good visual and aural appeal.

4. Oh yeah, the chassis(s) had to fit between the rails of a standard EIA relay rack.

I ended up with a design that is really quite simple (except, maybe, the somewhat elaborate heater supply for the input tube). However, with the very low parts count comes the extra high sensitivity to component selection. At the same time, it makes the design that much more fun to play with! Aside from the expense of some of the components, it makes an excellent home brewer project.

Since the inspiration for this amplifier was the output tube, it seems appropriate to start with a discussion of the output stage.

My original output stage was completely conventional. But I found that the quiescent current (150 mA) of the VV52b greatly limited the selection of output transformers.

The solution was to shunt-feed (a.k.a. *parallel-feed* or *parafeed)* the output. Now I had seen this done with choke coupled stages on vintage radios and had experimented with parafeed choke and autotransformer-coupled driver stages, but it had not occurred to me to apply this method to the output stage.

Some time ago I had a discussion about choke coupled stages with Mike LaFevre, of MagneQuest, who told me that he had been working on parafeed output stages with Dan Schmalle (a.k.a. Doc Bottlehead of Electronic Tonalities). The VALVE group in Seattle had been doing a bit of experimenting with these output stages (a lot since then!). It hit me like a hammer that these clever folks really had something here.

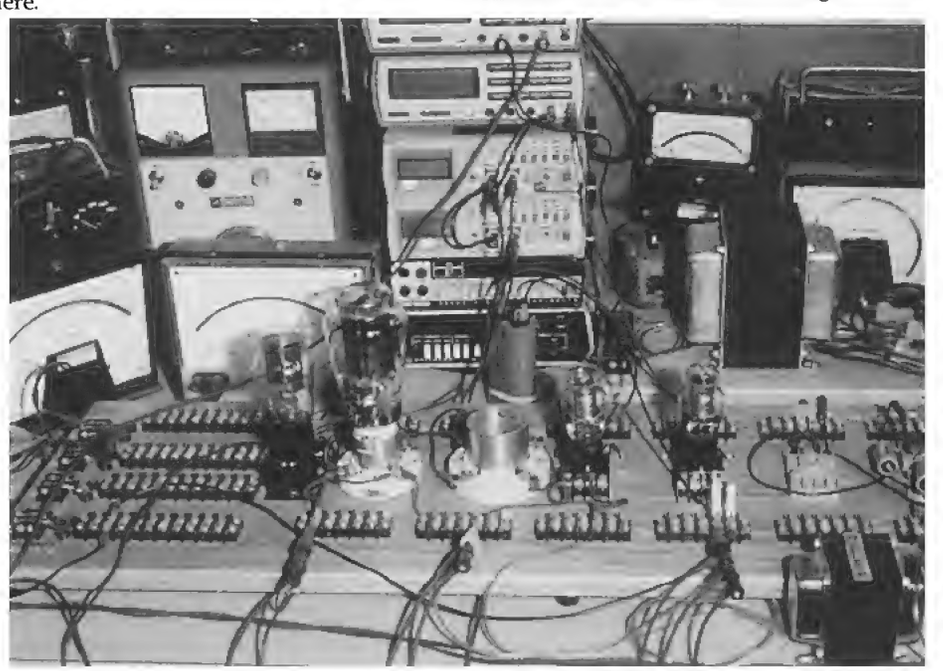
Of course there are some obvious reasons *not* to embrace parafeed coupling; the first thing people object to is the big DC blocking capacitor, where none was needed previously. The capacitor and the plate choke form a rather nasty filter whose implications made my computer draw cartoons.

Fortunately, I had enough parts to go ahead and try it out for myself. It's funny how sometimes things just work out for the best because so far I haven't found any sonic problems that I can assign to the parafeed topology. In fact it works very, very well! So build and listen, then talk!

What doesn't just work out is the added size and cost of the extra transformer. You haven't just eliminated the problems of DC current in the output transformer, you have separated the tasks and moved the problem to the plate load choke.

This separation of duty is a good thing though. It allows the plate choke and output transformer to be optimized with fewer parameters. In addition, the output transformer is returned to a lower impedance, going directly to ground as opposed to seeing ground through the power supply.

When building a substantial output stage with parafeed, you quickly discover that suitable plate chokes are damn hard to come by. Plate chokes are quite a different animal than a power supply filter choke. The plate choke has to be a wide bandwidth device while coping with both a substantial DC current and AC swing. From an



Shown here is the prototyping board set up for testing the original B-52. The extra sockets are set up for alternate driver tube evaluation.

AC point of view, it sits in parallel with the output transformer, hence the parafeed nomenclature.

I was not able to find an audio choke that would handle my specification of 150mA and 400v swing at 450vDC. So I had to commission a custom design (contact me for availability).

Fortunately, for designs of 80mA or less, Mike and Dan have come to the rescue with a line of plate chokes and output transformers to support us parafeeders. In fact it seems like lately, the VALVE bunch has become a parafeeder support group!

From a practical stance, the values of the plate chokes you can use are reduced to the very few available for any given current rating. The way I look at it, consider the inductance values to be fixed by the marketplace and build around what you can actually get.

For the output transformer, I chose the Electronic Tonalities custom MagneQuest TFA2004 "Pinstripe" version. The "Pinstripe" gets its name from the alternating laminations of nickel and M4 silicon steel.

Speaking of which, here's the main advantage of this parafeed thing; you see, now that you have unburdened the output transformer of DC current a number of design options open up. The core no longer needs to be air-gapped and the only saturation components are the primary voltage swing and output power. This means that you can now use exotic high-permeability materials, interleaved with steel or all nickel or whatever.

With a parafeed output stage you have another choice to make. You can place the DC blocking capacitor between the plate and the output transformer primary, or between the primary and ground. I found the differences to be fairly subtle but decided to go for the ground leg location. I really can't say if this was purely a sonic decision or biased by an intuitive feel that this configuration has the least influence on the signal. To size the blocking capacitor, choose a capacitance where the reactance is the same as the inductor at a given cutoff frequency.

The operating point for the VV52b was set by fixing the plate voltage at the recommended 450v. Then find a bias voltage and current that was just enough to make the tube sing but backed off enough from the specified maximum plate dissipation to extract as much life as possible from these expensive tubes.

Although you can find many theoretically sound bias points for this tube, it really sounds best with a higher plate voltage. The Vp voltage was the most dramatic knob on the prototype bench.

After trying a number of operating points, I found that the manufacturer's suggested operating point sounded best. If you allow B+ to fall much below 450v you start losing its distinctive high end and low end punch. However none of the four prototypes could get close to the plate current and power rating claimed by the manufacturer. All the tubes I tried have produced between 12 and 16 watts at around 135mA. Now at this operating point, the tube seems to be running effortlessly, even at full input voltage at 20Hz. The envelope temperature remains reasonable and those huge finned plates show no signs of stress. This seems to indicate that the tube could be pushed a lot harder.

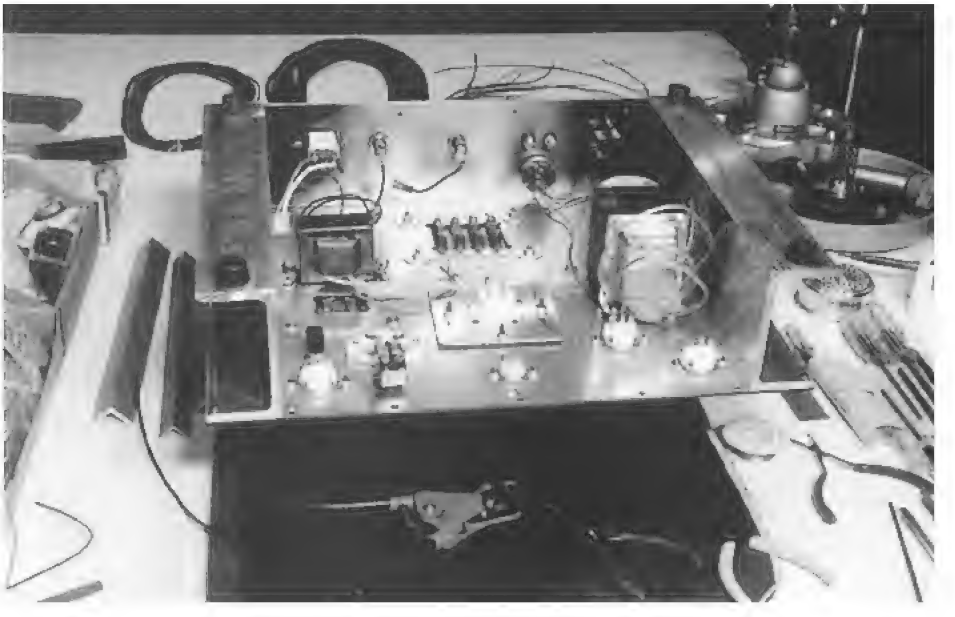
I have so far refrained because I haven't felt the need to increase power, I love the sound as it is (so why fix it?) and, with the high cost of these tubes, I would just as soon have them run at a relaxed dissipation. When I get some extra time I will be trying some more aggressive operating points but for now I just want to enjoy the music!

The bias point of the output stage dictates a driver capable of swinging 200v. In addition, big power triodes like the VV52b and the 845, are quite capable of sourcing grid current so the driver can't be too wimpy.

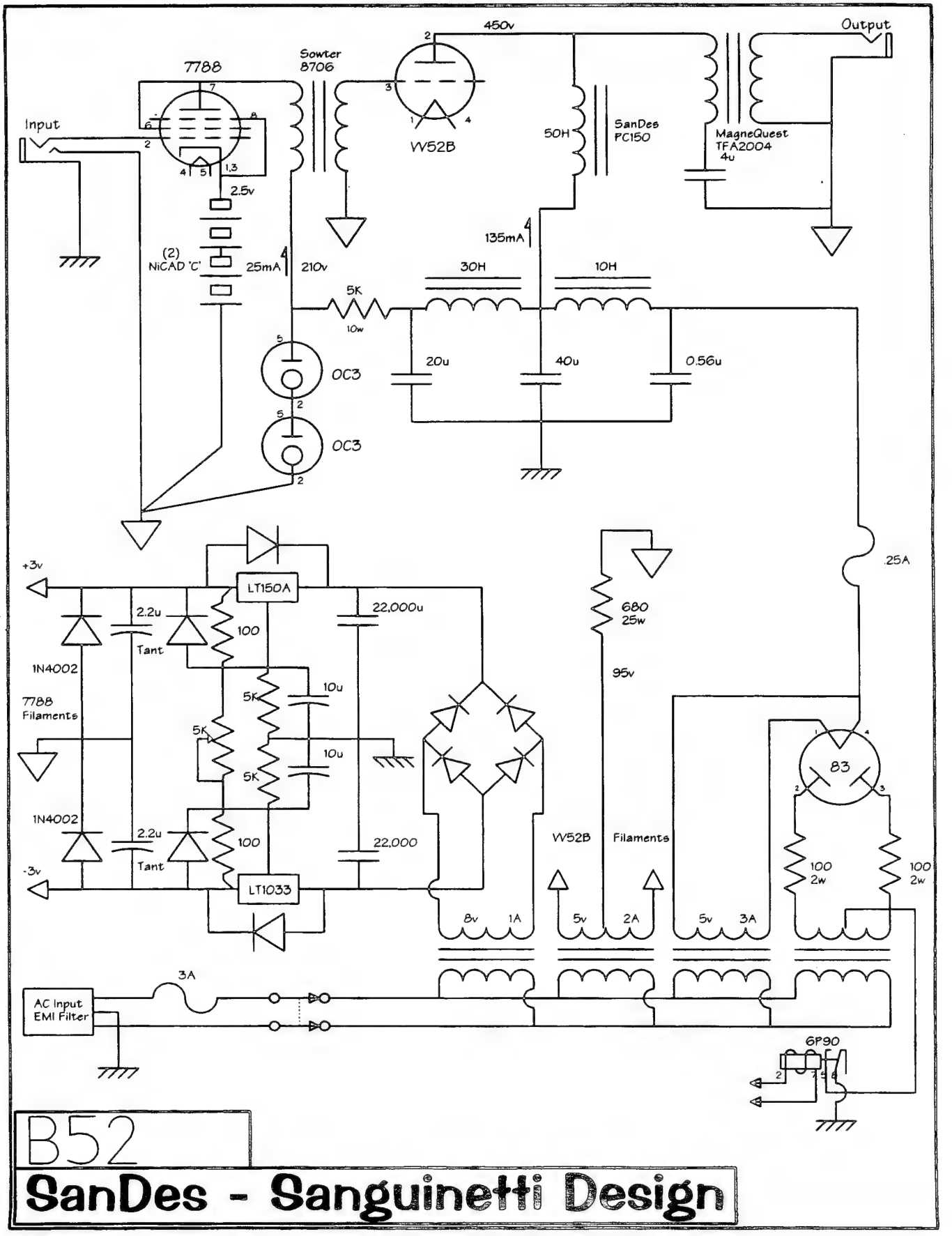
I immediately gravitated to a transformer coupled stage. I have been using interstage transformers a lot lately. They are really addictive, so beware! The simplified topology plays right into the goal of minimal device count since they perform the function of a choke load as well as AC coupling to the following stage. Transformers also really help the driver tube control the load, especially if employed in a step down configuration. The inductor load of the primary also allows the driver to swing up to and beyond the local B+ supply voltage.

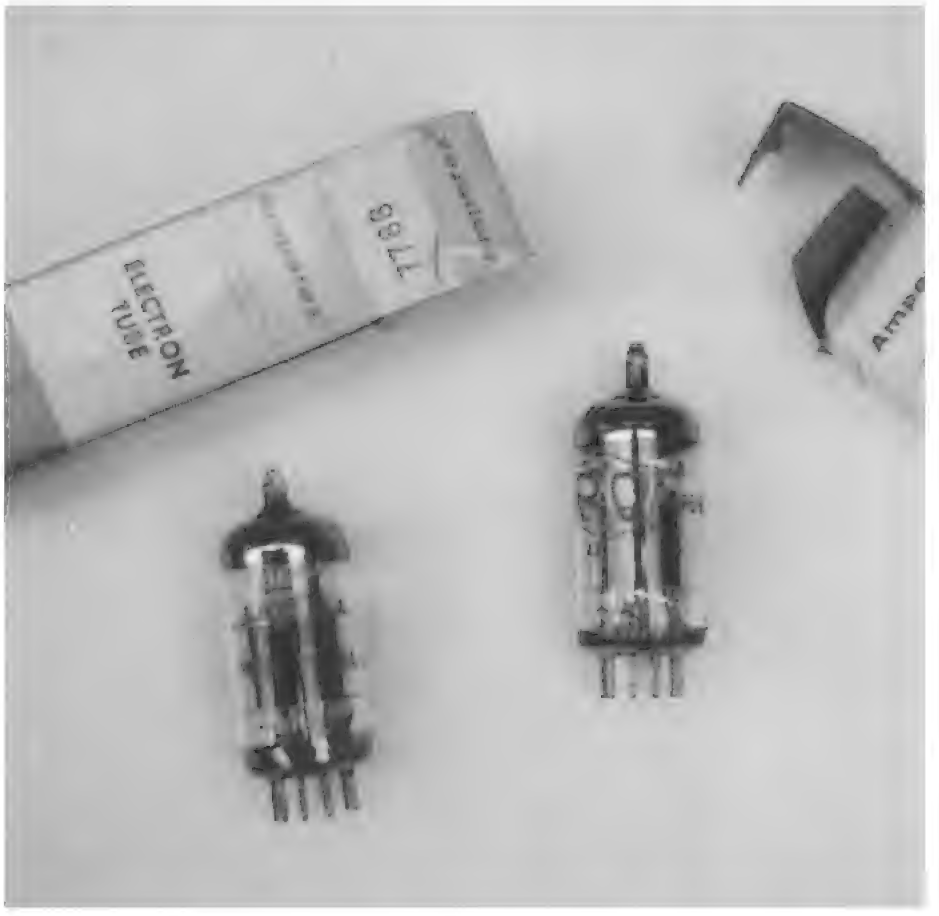
I had some husky Sowter 8423's (5k primary@30 mA, 1:1+1 ratio) on hand from my PP6B4G project. They sounded great in that amp and in Mike Hathaway's SE 6A3 amp so they were the first thing I tried here.

I started with a cascaded 5965 driver, transformer coupled to the output tube. For those not familiar with this tube, it is a long life version of the 12AV7, intended for computer operation. Although this tube is widely overlooked, it is a good candidate for general-purpose voltage gain stages, with an Rp of 7K and a *mu* of 47. The 5965 was introduced in 1952 and built by GE,



View of a prototype under construction, showing the interior component placements. Notice the subchassis for the power tube socket, a Yamamoto in this case. The large Sowter interstage transformer is on the right and the filament transformer for the output tube is on the left. Not yet mounted in this example are the electrostatic shields separating the power supply components.


B52
SanDes - Sanguinetti Design
7788
Sowter
8706
450v
Output
Input
W52B
50H
SanDes
PC150
MagneQuest
TFA2004
4u
2.5v
(2)
NiCAD 'C'
25mA
210v
135mA
30H
10H
5K
10w
20u
40u
0.56u
OC3
OC3
+3v
LT150A
2.2u
Tant
100
22,000u
1N4002
7788
Filaments
5K
10u
5K
5K
10u
1N4002
2.2u
Tant
100
22,000
-3v
LT1033
680
25w
95v
.25A
83
W52B
Filaments
100
2w
100
2w
8v
1A
5v
2A
5v
3A
3A
AC Input
EMI Filter
6P90



RCA, Sylvania and Tung-Sol, and good NOS specimens are common and inexpensive.

The 5965 design, although good sounding, was barely adequate in terms of drive voltage for the VV52b. Looking for a bit more gain, I explored the use of single high gain tubes.

Last year I experimented with tubes like the WE417A/5842, WE437, 6J4WA/8532 as drivers for a PP6B4G amplifier. Of these I liked the 8532 best. It biases up a bit higher than the others, has a bit warmer sound (at least in this amp) and is by far the best value of the bunch. The 8532 was introduced in 1964 and built by RCA and Sylvania. Used as a single stage, these drivers would require a step up transformer for adequate gain.

Then Joe Lowe brought the 7788 pentode back to my attention. Many lives ago, an RF engineer had told me about this tube but I had dismissed it out of hand because it had too many electrodes. After all, isn't the pentagram the devil's logo? Dooh, take a look at your hands and feet. Five can't be all that bad?

Heck yes, the triode-wired 7788 *is* the ultimate small signal voltage amplifier. When combined with the Sowter 5K interstage transformer hooked up with the secondaries in series (1:2 ratio), this gain stage can swing 450v before showing any symptoms of stress! At 200v it lopes along at 0.163%THD. Ee-yow!

OK, so the instruments are impressed, but how does it sound? Well it is a little silly to talk about the sound of the driver apart from the output stage, so let's just say that I stopped looking at alternatives when I heard this one. The 7788/E810F was introduced in 1961 and was built by Amperex and GE, though rumor has it the GE's were built by Amperex.

The initial measurements were taken with a Vp of 134v @ 35mA into an instrumentation load of about 300K. It was down 3dB at 5Hz with a gain of 112 (with the transformer strapped for 1:2). For the final configuration in the amp I opted for a higher bias point to increase the input headroom. The tube seems to like this just as much. The higher bias also lowers the DC current through the interstage, although the big Sowter worked just fine at 35mA. The new Vp is 190v and it now draws 28mA.

Based on my experiments on the PP6B4G amp, I went with the battery cathode biasing scheme. You place a positively biased rechargeable battery in series with the cathode, replacing the cathode resistor. A bypass capacitor is not required since the battery provides a very low impedance AC ground.

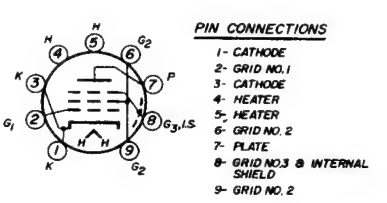
For this design I use two C-size NiCad batteries in series for about 2.8v. As it turns out, not all NiCads are created equal for this application. I started out using a couple of Radio Shack batteries. When I first powered up the design, on the protoboard, it was very unstable. It would go berserk as I moved the probes around. I eventually noticed that all I had to do was move my hand close to the batteries and the stage would take off. I wasn't trying to build a

AMPEREX TUBE TYPE 7788

TENTATIVE DATA

The Amperex 7788 is a dual frame grid, long life, shock and vibration resistant pentode, especially designed for use in broad-band amplifying circuits such as radio and television relay systems, coaxial telephone lines, radar equipment and oscilloscopes.

The 7788, an Amperex "Premium Quality, 10,000 Hour" tube, features extremely high transconductance and an excellent figure of merit. The low noise equivalent resistance is typically only 100 ohms pentode connected, and 60 ohms triode connected.



thermin, so I tried a pair of yellow Eveready's. Now the stage is rock-solid and another lesson was learned.

The battery, power supply and tube are all wired in series. So the battery is sinking current, a configuration that constantly charges the battery. Before, I had space heaters that played music. Now I have one that is also a battery charger!

I have been told to hold a constant charge current below 1/20th of the Ah rating of the battery. Since C NiCads are rated between 1800mAh and 2400mAh this load is well inside their margin of safety. It is important, however, to keep the batteries away from heat sources as this will lower their life span faster than anything else.

Although the amp sounded great, I was noticing a little overshoot and ringing at the secondary of the interstage transformer when driving with a square wave. I discussed this with Brian Sowter, talking about what kind of optimizations we could make.

The plate impedance had been measured at 1.3K so I could afford to lower the primary impedance of the transformer. This would in turn lower the inductance but there was room to play because the low frequency rolloff was so low. You can estimate the rolloff by $f3 = (Rp + Rdc) / 2\pi L$. I ended up opting for a primary impedance of 2K.

This customized version of the 8423 can be obtained from Sowter as model number 8706. The amp still sounds great, but the instruments are a little happier with the square wave response! Got to throw those hard working instruments a bone once and a while...

I generally view complexity as a bad thing. Every component adds its own noise and parasitics, all parameters that shape sound. The input stage certainly has a very low device count, with only a tube, a couple of batteries and a transformer. Oh, I use a ferrite bead on the grid, so to be fair, I should count that also. The bead is used instead of a series grid-stopper resistor.

The power supply is choke input, although it does use a small capacitor just before the first choke. This helps with ripple filtering and can be small enough so that the effects of the choke swamp those of the capacitor.

In other words, the supply still acts as a choke input supply. I thank Gordon Rankin for this simple trick. I like to refer to the pre-filter capacitor as a tuning cap because it tunes the power supply characteristics between those of a capacitive input filter and a choke input filter. A choke input filter generally results in better voltage regulation whereas a capacitive input filter yields better ripple filtration and at the same time provides higher output voltage.

Viewed purely from a topological point of view, the amp uses a CLC filter. But from a qualitative perspective, it is still an LC filter.

The size of the tuning capacitor must ultimately be determined empirically. The output voltage is very sensitive to the cap value. I generally start off with .5mF and work up to no greater than 2mF. We are trading off reduced hum and higher output voltage against better regulation and better sonics. Naturally, I try to keep the capacitance as small as practical in order to maximize the choke input characteristics.

Unless I need solid state rectifiers, or the voltage or current load is too great, I inevitably fall back on the venerable 83 mercury vapor rectifier. It is worth the small added complexity of the B+ delay circuit, required to hold off the plate voltage until the filament has liquefied the mercury. The rectifier and tuning cap are followed by a large, low DCR filter choke. The LC filter is completed by modern manufacture GE motor start oil caps.

After tapping off for the output stage there is a second LC filter followed by the driver stage plate supply regulator. This is a shunt regulator consisting of two stacked 0C3 VR tubes and a series current limiter.

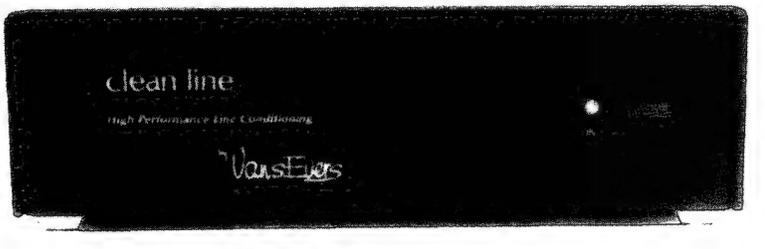
Although I feel that power supply voltage regulation is fundamentally good, the complexity of most regulation schemes betrays their benefit. The 0C3s do a fine job for a minimalist regulator and add priceless esthetic appeal. After all these years, I still giggle every time I see them hit excitation voltage.

To ensure good regulation, the current limiting resistor is sized so that current through the VR tube is below the maximum allowed for the device. In the case of the OC3, this is 40mA. For best regulation, limit it to about 80% of maximum. We also need to make certain that at all times the plate sees a voltage higher than the minimum excitation voltage. The OC3 needs a minimum of 133v, or 266v for the series pair and at least 5mA.

The output voltage is the voltage drop across the tube, which is 103v or 206v for the pair. For this Class A stage, the load current is pretty stable and within the load

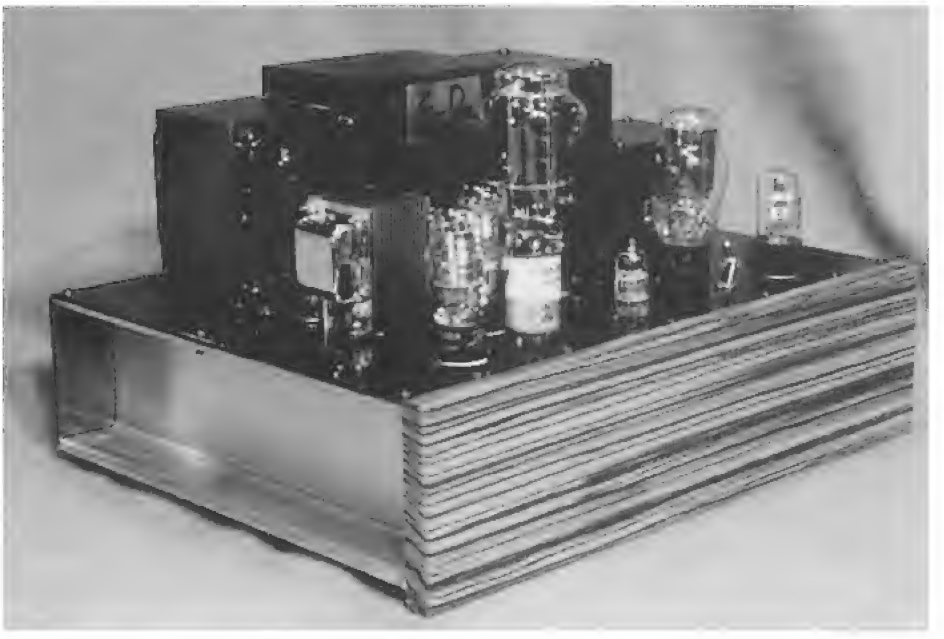
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rating of the VR tube so I just used that for the tube current. The series resistance is calculated as R = (Vin - Vexcitation) / I. The excitation voltage for the OC3 is 133v, as mentioned above.

So how does it sound? The VV52b is a crystal clear, detail king, without the high frequency sizzle one associates with an "audiophile" sound. The bass is authoritative and punchy. Being a bass player, this is very important to me. I was originally going to use a PP845 design for the bass and biamp but after listening to this amp I have decided to just use it full range. I will save the biamp rig for when I get bored and have to add something to the system— you know how that goes!

The cost of the Kron VV52b and the corresponding plate choke, combined with the limited availability of the 7788 has prompted me to offer some alternative suggestions. These will still produce a great sounding amp, even a bit more romantic.

As an alternative to the VV52b I suggest the 845. It can be run at the same plate voltage at a more moderate current than the VV52b, although I did prefer the 845 sound at a higher plate voltage. In my prototypes, I raised the plate voltage by simply moving one of the 20uF caps from the first filter stage to the front of the choke. This replaces the small pre-choke cap and converts the supply to capacitor input, raising the output voltage.

When I did this, the series resistor for the 0C3's needed to be increased to allow for the higher B+ voltage. If you want even more volts, you can convert to a full wave bridge. I would choose solid state diodes, followed by a damper diode, or four dampers if you don't object to the added resources.

Alternatively you could choose 816 or 866A MV rectifiers. Of course for the 845 you will need to substitute a 10v filament transformer for the 5v one used for the VV52b.

The 845 version doesn't have quite as much punch in the bass and the highs are not quite as glistening, but it makes up for it with a lush midrange. In fact it is a hard choice between the amps because they are good at different things. One bonus of the 845 is that the lower current requirements allow substitution of a MagneQuest B.A.C. 50H, 80mA choke, saving both money and weight.

As an alternative to the rare and subsequently expensive 7788, I suggest using the cascade 5964, 5965/7062/E180CC or 7119/E182CC and using the stock Sowter 8423 (5K) interstage. Some of these will require adjusting the B+ voltage, for instance replacing the 0C3 stack for a single 0D3. Some also have enough gain, in cascade, to allow wiring the interstage secondaries in parallel (1:1 ratio).

Not shown on the schematic are two negative temperature coefficient (NTC) thermistors, known as inrush current limiters, placed in the primary of each filament transformer. These are resistors that start out at some higher resistance and then decrease in resistance as they heat up. They act as a soft start for the tube filaments. Your expensive tubes will appreciate the gesture. For the 7788 you can use the Keystone CL-130 (Digikey #KC013L) which starts at 50 ohms and settles out at .75 ohms. It is rated at 1.6A. For the VV52B I used the Keystone CL-190 (Digikey #KC019L) which is rated at 25 ohms going to .4 ohms at 2.4A.

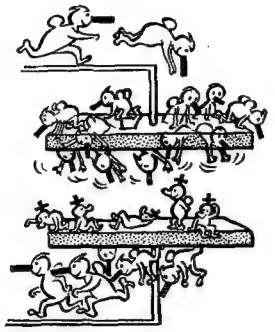
The chassis design was intended to occupy the space of a conventional audio component and fit between the rails of an EIA relay rack. Some experimenters have noted microphonics problems with the VV52B. Although I have not experienced this with my prototypes, I chose to mount the socket on a subchassis suspended from the main

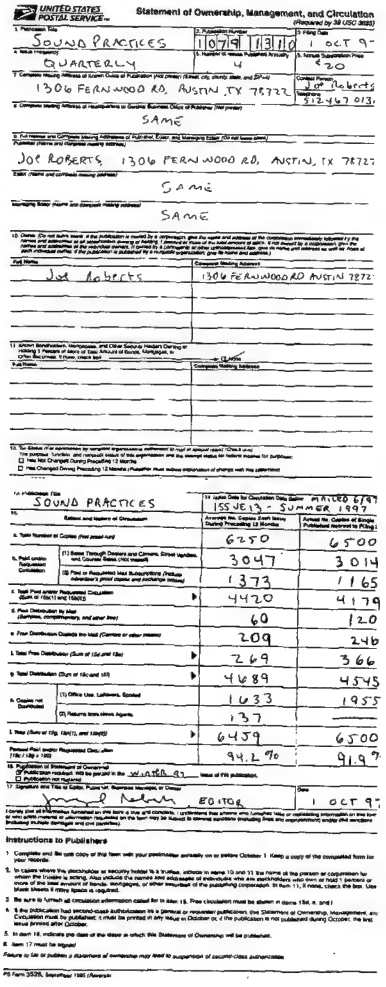


chassis with rubber standoffs.

The chassis is comprised of a single plate of 1/8th inch aluminum with a bent section that forms the top and back panel. The sides are 4x2 inch aluminum U channel extrusions and the front is machined out of rough-cut selected Zebrawood. The finish on the top and back panels and the transformers is black Hammerite. This completes goal number 3! A fine-looking piece if I do say so myself.

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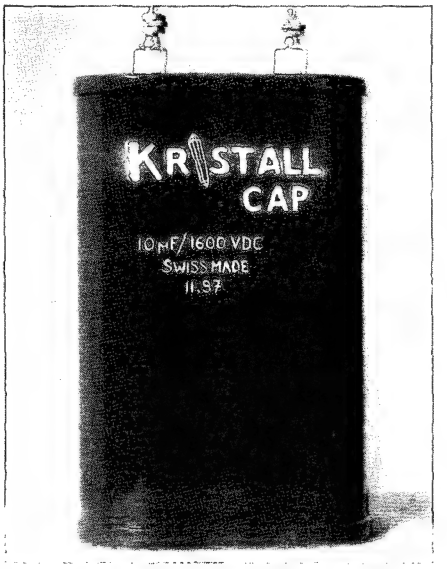
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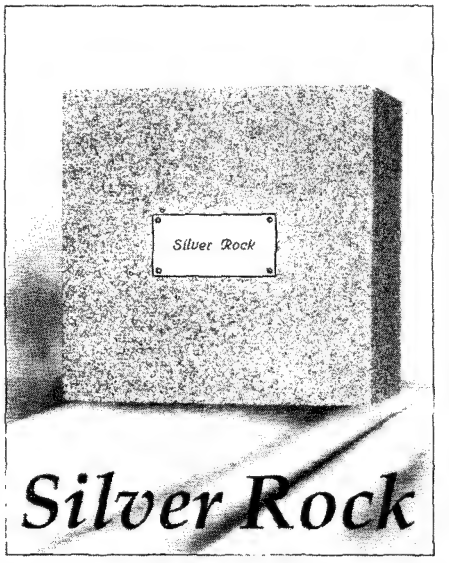
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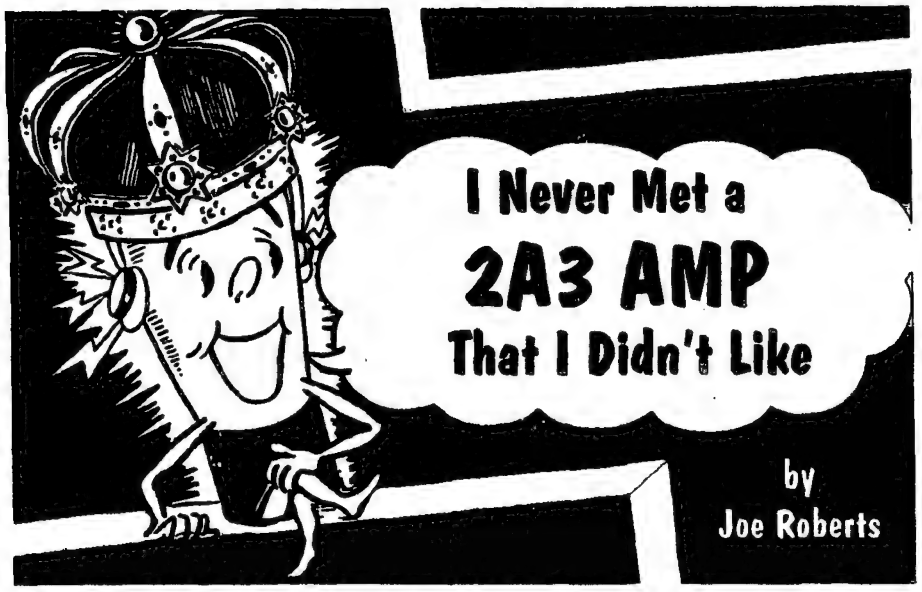
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Nothing in audio is a sure deal but if I were forced to come up with a foolproof recommendation to stake my name on, I would have to go with the classic no-brainer: "It's hard to build a bad 2A3 amplifier."

There might be some bad ones somewhere but I have to say that every 2A3 amp I ever had the pleasure to hear was at least pretty good and some were downright amazing.

My introduction to triode amps came with restoring a few Brook 2A3 amps of the early 1950s, which I didn't get to hear until they were certified antiques in the early 1980s. Even in the late 1940s/early 1950s when they were current models, the Brook designs were a throwback to prewar technologies (see *SP#2*), valued by a few purists who knew that those newfangled pentodes were nothing but a sell out.

The Brook 10C wasn't even a pure Class A design or anything. It used a sliding bias adjustment scheme to switch the push pull 2A3s way into AB2 when the signal peaked. Yet, despite this elaborate and somewhat dubious conception, the 10C still sounded very very good. Real, real good, in fact.

In an attempt to come up with a simpler amp than the Brook 10C, I built the "Recording Amplifier" shown at right (minus the mic preamps). Glory, this was a mighty fine sounding amp and I'd build another one in a second. The "triode sound" is still really there with PP topologies and...*Man*, you can really get some low end out of a pair of these tubes. After all the 2A3s were chosen to run a record cutting head because of their good damping behavior even sans feedback.

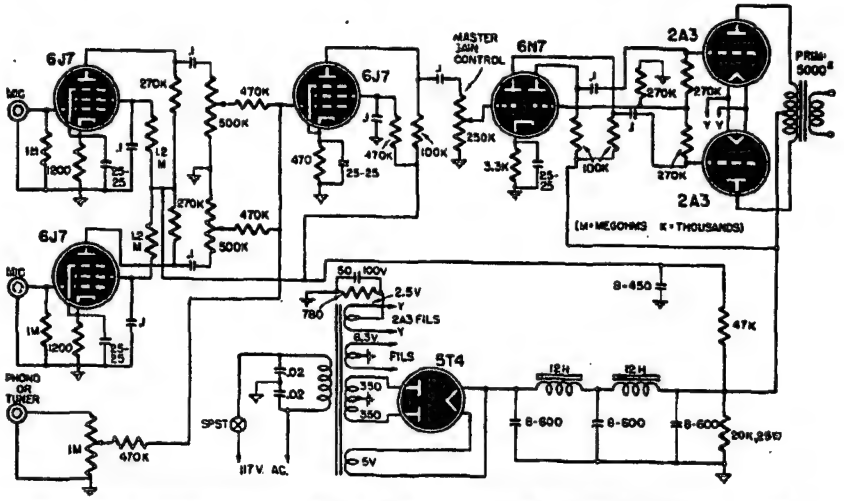
Yeah, somehow PP 2A3s fell through the cracks in this age of SE mania, but, on the other hand, maybe a single 2A3 amp is about as good as it gets. My first exposure to SE amplifiers was a shot in the dark. I remember looking over a SE 2A3 circuit in the 1940 *Radiotron Designer's Handbook* (third edition), provided as an example for calculating the response of the circuit and thinking "Hmmm?"

With a few voltage adjustments, I figured I could scrape a single amp out of my "Recording Amplifier" by hooking the 6J7 straight into the grid of one 2A3. I didn't have any SE transformers back then. I just ran the DC through the primary of my vintage push-pull UTC LS-55 transformer.

When I turned this Frankenstein on I was floored. It sounded *way* better than it should have. It was a looser, more open, more organic sound than the PP 2A3, and although the bass wasn't as tight as the PP amp, it was very expressive. This experiment was obviously taking me somewhere I thought I might like to be.

Now, after years of study and experience, I might comment on how the 6J7/2A3 combo is reminiscent of the classic WECO Model 91 pentode driver/300B circuit and blabber on in an Ultra-Fi "dress-to-impress" patois about esoteric bullshit that doesn't matter anyway. Seems like everybody is a triode amp expert today, but back then I didn't know anything but what I was hearing. That's all I needed to know. The rest is history.

One of the things that I know now that I didn't back then was that Nobu Shishido, one of the "crazy Japanese guys" who revived the triode amp, wrote the first article about SE in the modern era in a



10 Watt Push-Pull Class AB1 "2A3 Recording Amplifier" from 1948

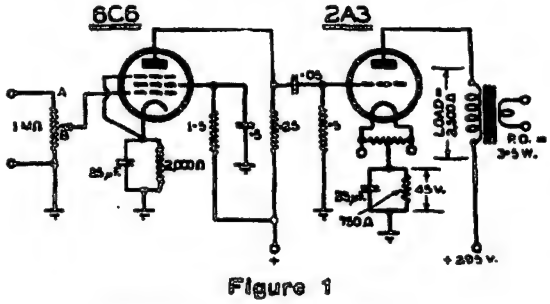


Figure 1

Radiotron example circuit

Japanese experimenter mag about a 2A3 "Loftin-White" he originally built from dumpster TVs while an MBA student in Oregon during the late 60s.. He didn't "go single-ended" to be hip. It was a cheap and easy way for a poor tinkerer to get some music playing in the dorm. Anyway, that amp ruined old Nobu for life.

The last SE 2A3 amp I built was inspired by JC Morrison's degenerate Loftin-White lash-up called the *Micro 3.5* from SP #6. The custom features of my implementation included a bank of *Western Electric* oil caps and a tasteful pink-and-white speckle over gray primer paint scheme. There were only a few lonely parts underneath that big, ugly "budbox" chassis, making it an air box beyond anything ever dreamed up by the mass marketeers.

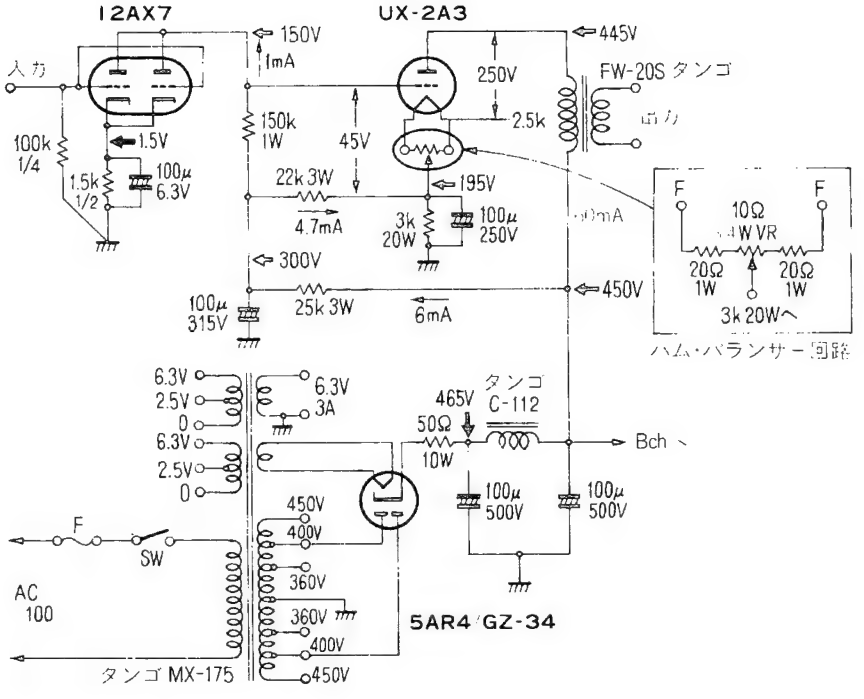
Also, I used indirectly-heated 6A5-Gs instead of directly-heated 2A3s, which sounded just like real DHT 2A3s to me but there was zero perceptible background noise even on a horn. It was a weirdo, one-off creation and no big looker, perhaps, but this amp kicked ass and took names, I swear!

I gave the 6A5 amp to a Korean friend of mine, who eventually lent it to a hi-fi magazine editor back home. The editor has since refused to return it, probably because it sounds better than almost anything you can buy! No surprise there. Look, it showed up in the pages of a Korean audio mag!!

Nobu Shishido probably loves the 2A3 as much as any man who ever walked the earth, but he has moved on in his own technical/aesthetic quest to exploring the grid circuits of transmitting tubes and the practical work of restoring old opera 78s. He downplays the 2A3 with a been there, done that attitude—"Sure the Loftin-White was a great amp but if it was *that* great why isn't everybody listening to Loftin-Whites?"

I'd be the last person to argue against audio diversity and the forward march of progress, but I do believe that everybody should be required by law to enjoy the pleasure of a good SE 2A3 amplifier for a while. There is great reference value in knowing how much you can get with so little.

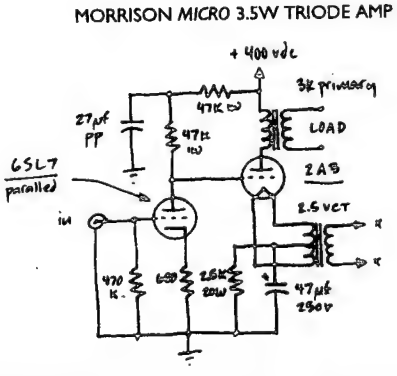
Fortunately, in this day and age, you can buy super-quality parts to put together a 2A3 of your own, or buy USA-made 2A3 amps, your choice of finished or kit form. For the last 60 years, you had to *really* work to hear 2A3s, but now it's probably easier than it's ever been. That is a strange historical fact and the more I think about heavy historical facts like that, the more I want to stop thinking, spark up a 2A3 myself, and just listen, if you know what I mean.



Above: Nobu Shishido's famous 2A3 "Loftin-White"

Right: JC Morrison stripped down Micro 3.5 from SP #6

Below: My homebrew Micro 3.5 made the news in Korea!! Don't know what they said about it but I'm sure the words "kicks butt" are in there somewhere



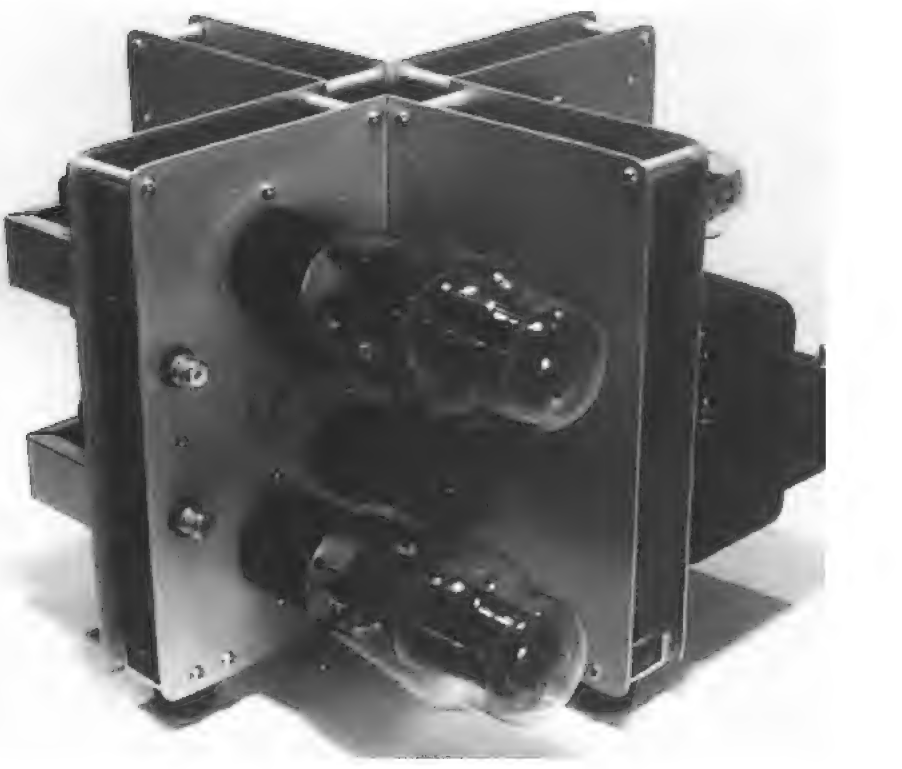


6A5G관 진공관을 사용한 이 앰프의 출력은 약 3.5W. 그 몸집없는 모습과는 달리 음질만은 매우 매혹적이었다.

Fi "X"

direct coupled 2A3 SE

$895 with Hammonds
$1175 with MQ iron



I could hardly believe my eyes with the "X" ad spread out in front of me. First of all, you have to ask "What is it?" The answer is that it's a stereo 2A3 single amp. Who would have thought?

I don't usually get sucked in by slick advertising campaigns, but the second I saw the ad for the Fi direct coupled 2A3 "X" amplifier, I immediately had to own one. As a homebuilder, I don't often get the urge to whip out the Amex card for storebought gear but the "X" really hit my button hard.

Despite all the charms of the 2A3, "best tube" according to many confirmed triode nuts, there isn't much perceived desire to own three watt amps yet. People just don't realize what they can do, yet.

Fi's Don Garber has always made 2A3 SEs and I think he always will. Among professional American amp makers, Don is alone in his unswerving dedication to the ancient 2A3, half-pioneer, half-keeper of the faith, and half-artisan—a man of many halves.

"Mr. 2A3" Garber is also in a class of his own as far as visual design goes. You would think you might have to go to Italy or something to get this kind of symbolic *objet d'art* approach to amp design, but Don just dreamed it up while riding home on the subway, "A freakin artist," as they say in New York.

The "X" Amplifier is truly The Death of the Box. The insides of this amp are mainly on the outside. Actually, it's hard to say what is inside or outside. It reminds me of a revolving door.

Anyway, when my eye settled on that glossy b&w "X" promo snapshot, I instantly decided that I could never be cool again until I had the "X" playing in my system. And, aside from the unquenchable thrust to maintain a hipster self-image,always the best reason to buy audio gear, I had just rebuilt my bi-amp horn setup, using TAD 2001s and Altec 1505B multicell horns. I knew that a single 2A3 would be just the thing to run that overgrown fifteen cell tweeter.

If one could say this amp is art, and I would say so, it is industrial art. It is meant to be plugged into the wall and turned on and used. And treated with some due respect—the open nook and cranny construction and silky aluminum surfaces of the "X" invite the eye and hand, while the B+ terminals lie within reach, daring the uninitiated finger to probe the mysteries of its forbidden interior...

I later found out that Garber *usually* ships the "X" with a protective metal shield, but he shipped mine bare. Now I *know* he's trying to off me, before it was all just talk.

Back in early-80s NYC, the "X" motif was tied in with the whole punk sparseness aesthetic that was so hard to avoid if you lived in the city. Don might remember this, since the "X" circuit adopts a staunchly minimal pose from the standpoint of parts count. This unit is a ruthlessly pruned-down version of Fi's regular 2A3 direct coupled amp, itself already a lean, mean, low parts count machine. The "X" is the Sid Vicious of 2A3 amps. Time to get out the New York Dolls records.

Minimalists take note: the "X" is almost the least hardware you can use for the job— a pair of 6SF5 metal high mu triodes with the plates wired straight to the grids of the 2A3s, a couple resistors and a few electrolytic bypass and filter caps. If simplicity is a virtue, the "X" is a saint. There isn't one extra screw in the whole assembly.

On the other hand, Garber does spring for a tube rectifier, which I was very glad to see, because I know it makes a big difference in the musical flow of an amp's presentation. It's reassuring that Fi didn't skimp down to the 10 for $1 silicon rectifier level of minimalism, but instead chose the inefficient, wasteful, purist high road. This amp wouldn't be what it is without that tube rectifier— it's as simple as that.

The "stock" trannys are $75 a pair Hammonds, with MagneQuest DS025s available for an additional buck-fifty per channel. When quizzed, Don seemed noncommittal on the value of the $280 upgrade, saying the difference was "not as different as *some* people might like to think."

I still don't know what the heck that means, but I detected the distinct musky aroma of a reverse-cool parts choice statement in there somewhere. So, I told him, "Look, I useta live in New York myself, just hold the iron, cut the price, and I'll install my own pair of Magnequest trannys." Had some MQ TFA-204s I shook Mike LaFevre down for sitting idle on my workbench and

they were already paid for and broken in, know what I mean?

That may be, but now I feel like I lost out on the cheapo/minimo posture of using the Hammonds and now I wish I had those cheap Hammonds for the urban coolness factor. I know the MagneQuests are probably technically better transformers, but so what?

Visual aesthetics aside, in terms of musical refreshment, I must say that the Fi "X" marks the spot. It's definitely worth the risk of painful electrocution to enjoy an amp with a rich soulful presentation that quickly puts me in the right mood like this amp does.

To generalize, the Fi amp has more of a celebratory musical posture than an analytical presentation, and this is what I am looking for to run my HF horn. It has a soft, seductive, whispery quality that makes me feel like it is singing right into my ear.

I must say that nothing in my experience compares with a good 2A3 in terms of getting just the right balance between *dramatic* and *natural*. A 300B can be more dramatic in some applications, and done well that can be mindblowing, but you always know you're getting a show. The 2A3 pose is perhaps a tad more restrained and a bit easier to believe most of the time.

That said, I wouldn't want to imply that the "X" is a *neutral* sounding amplifier at all. It delivers the full psych-o-delic special effect that triode amps can produce. The "X" creates a narrative drive beyond the usual realm of realistic reproduction, edging into a kind of intimate hyperrealism, but don't knock it until you've tried it. No matter how long I sit there trying to understand and deconstruct the 2A3 illusion, it doesn't go away.

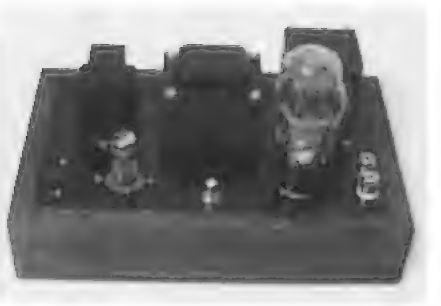
I expected top midrange out of a DC 2A3 and I got that with the "X" but the unexpected BASS performance on my Altec woofer definitely put some funk in my trunk, with grunt factor well beyond my expectations. I do get a bit more weight and control with my "big" 18W pp 6BQ5 Dyna ST-35 on the woofs, but in terms of punch and rhythm, the "X" was no slouch. A cute and effective rig up would be a pair of "X"s for a one-"X"-per-side bi-amp arrangement.

H'mmm, maybe I can work out some kind of involuntary payola arrangement with Don Garber, once he knows I know he usually ship the amps with a metal safety cover—either that or "Move over Jimmy Hoffa, Mr. 2A3 goin out to summer camp in the Meadowlands." They'll be saying, "Yeah I remember Garber, the guy made a helluva 2A3 before he went to Jersey!"

ELECTRONIC TONALITIES

AFTERGLOW

2A3 Direct Coupled Mono Kit Amps



No article called "I Never Met a 2A3 Amp I Didn't Like" would be complete without reference to a 2A3 amp I never met. So, before I even get close to finishing, here's one that I only read about: The $849 *Afterglow* kit from Electronic Tonalities.

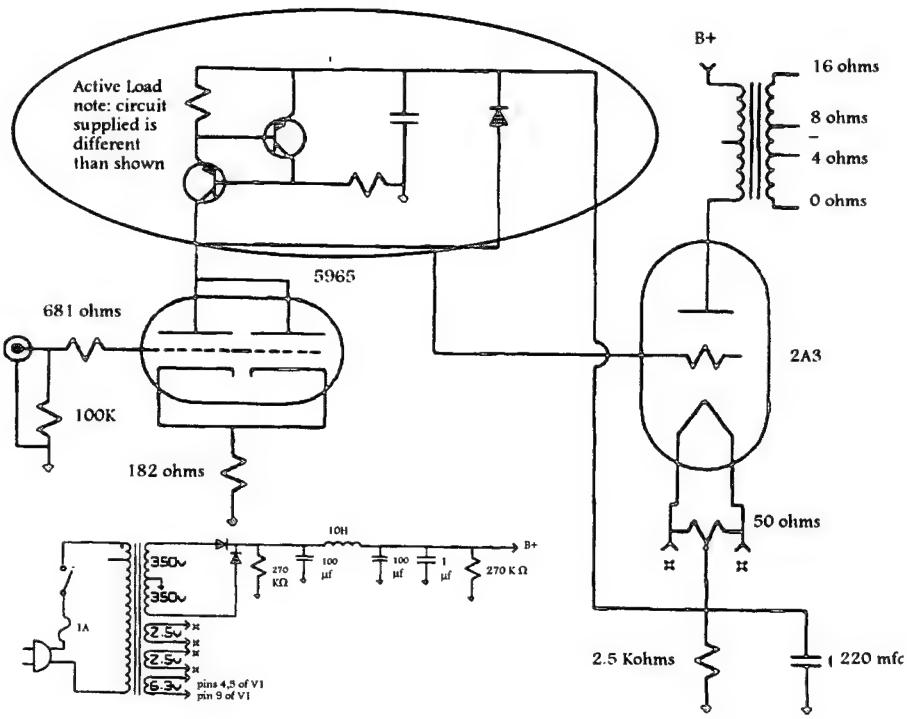
Like the Fi amplifier, the *Afterglow* is a direct coupled amp but, unlike the classical Fi "X" 2A3, the Electronic Tonalities design pursues a relatively high-tech approach to a simple two-tube circuit. North Texas amp guru John Camille and ex-Texas refugee to Washington State, John Tucker were involved in this project and those blokes are well known to prefer slick neo-technology over the "Pass the Radiotron, Dear" retro scheme a lot of tubeheads opt to pursue. If this were 1962, these guys would definitely be toting foot-long slide rules on their belts, I'll tell ya.

The driver is a paralleled 5965 running into a Camille C4S cascode constant current source contained on a little circuit board. The advantage of this hookup is that the driver tube sees an *extremely high* load impedance (>5 megΩ)! They sell the board separately if you want to mess with it.

Since I never heard the amp, obviously I don't have too much to say about the sound. ET's Dan Schmalle says that the *Afterglow* is a very clean sounding piece: " A high level of sonic realism is achieved by the direct coupling of these stages"...blah, blah, blah. Know what,though? I believe him.

The *Afterglow* uses the little $99 TFA-204 from MagneQuest, a good sounding cheap transformer that I used in a number of amps, including my Fi "X." It might not be the best or fanciest output in the whole wide world, but it's good enough for me.

According to the book, the *Afterglow* is good for 2.4 W at 5% distortion and the measured frequency response charts out at -1dB at 28 Hz and 19 kHz. But who cares?—nobody buys 2A3 amps from the spec sheet anyway.





Welborne Labs

MOON-DOG 2A3 monos

Kit Less Tubes $1149

I really like the name of the *Moondog* 2A3 monoblocks from Welborne Labs, and not only because there is a certain timeless quality of regularity and dependability evoked by that lunar imagery. The cyclical theory of history implied by the endless gyrations of the moon kind of fits with the resurgence of this ancestral audio tube, for those who like a little millennial poetic justice and tidal forces with their audio gear.

Beyond all that deep interplanetary symbolism, the name *Moondog* dares to speak the obvious truth—that anybody who has to have a 2A3 amp probably too far gone into audio lunacy to relate to normal society anymore.

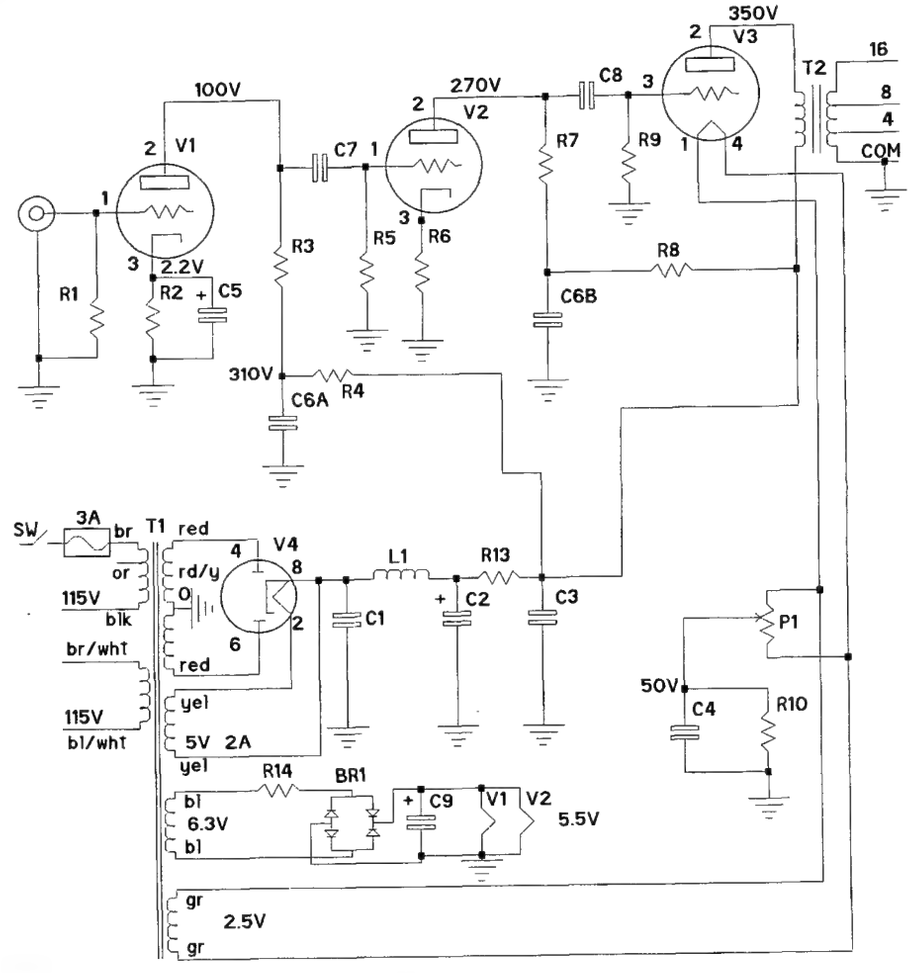
And Ron Welborne is in a good position to know about that freaky triode crowd. Hey, Ron, do sales go up during the full moon or what? After all, *you* came up with the name, buddy!

Consistent with the access to ancient natural secrets and dedicated insanity implied by the *Moondog* title, these amps feature the kind of classic technology that is hard to argue against. GZ-37 tube rectifier with a pi-filter using a choke, a pair of 6SN7s and a 2A3. Output transformer is the MagneQuest DS025, my personal favorite Philadelphia-wound transformer.

This amp is a solid, traditional, and somewhat conservative design and, in those respects, it represents what is worth keeping from the retro concept. Except for the DC heater supply for the 6SN7s, the *Moondog* is a throwback to a long-dormant 1930s all-triode amplifier paradigm, back from the ashes to play the music for the turn of the century.

Although I might have an intellectual reaction to a circuit, in one way or another, I don't really know how to think about the sound of a given circuit. A circuit is just an abstract picture until you build it out of real-world parts. And it is a particular combination of parts that gives each amp its actual sonic character. Often in my experiments with things like 2A3 single amps, I found that a coupling cap swap could impart more flavor than installing a whole new driver stage.

That being said, I still feel good about the *Moondog* schematic. You won't get burnt sticking with a classic framework like the two stage medium mu triode *Moondog* voltage amp stage and a 2A3. This approach has become a classic for many reasons, one of



Basic circuit layout of Moondog 2A3. A complete schematic, including part values is available in the kit manual ($15 refundable with kit purchase)

MoonDog 2A3 Amplifier
Welborne Labs
Copyright 1998

them being that a simple circuit that sounds good is a tested recipe for satisfaction. Getting fancy isn't always the point.

The *Moondog* might borrow from bygone traditions, but this amp does not sound very antique at all. I believe that's because of those modern hi-tech components. In these simple, no-feedback amps, you can really hear the parts, every single one.

In the instruction manual, Mr. Welborne says that at first he tried the vintage carbon resistor and oil/paper cap scheme and they were impressed with the tonal results. Then, after swapping in some boutique bits from the Welborne parts catalog, such as Caddock foil resistors, a couple Mills wirewounds, ELNA Cerafine caps, Hovland MusiCaps, and whatnot, Ron felt that they had to go with the fancy stuff for modern audiophile performance aspects, like big soundstaging and sonic detail resolution.

Welborne, ever eager to please, is willing to customize the kit per the customer's individual audio fantasies, so if you're after something special, give the man a call. It's a a kit, after all, so if you want to mellow it out with an oil cap or whatever, who's gonna stop you? Certainly not Ron Welborne. He'll even sell you the damn oil cap!

On the whole, the quality of the hardware and components that go into the *Moondog* kit are on the level to be expected from a specialist parts guy: Cardas connectors, OFC wire, name brand components out the wazoo. The *Moondog* package doesn't go over the top with swank and elaboration but there is no junk in sight.

The *Moondog* monos are packaged in the brass plate and walnut wood frame style seen before with the *Laurel* 300B amp. The look is natural and unadorned with a sort of rustic manly character. The amps look handcrafted rather than mass-produced, which is exactly what they are.

Like I said before, I think it's those newfangled *Welborne Catalog* components, but the *Moondog* I heard, Ron's personal stock *Moondog*, tunes the antique 2A3 for the modern 1990s wide-bandwidth, high-resolution aesthetic. The 2A3 is capable of presenting an astonishingly natural, high-definition 3-D scenario and this amp showcases that impressive trait.

This is one of the important things triodes can do: that very detailed presentation with enough harmonic depth and color to get the emotional encoding of the tones across. In my opinion, the added color imparted by the 2A3 is just what is needed to warm back to life that cold analytical concept of x-y-z axis positioning as a goal for hi-fi systems. Perhaps some "imaging" is necessary for realistic musical portrayal, but it is not in and of itself sufficient to get the illusion across. Imaging for me belongs the intellectual side of recorded music listening, not the immediate physical communication part. Without that special expressive juice behind it, the image is just a skeleton—the dry, objective component of phonographic realism.

The way some SE triode amps get the audiophile transparency illusion right without sacrificing the vivid life and tonal complexity of music has been a hit with a lot of listeners, including me. Such amps can be shockers to hear.

A clear-voiced 2A3 is especially good at sneaking up on you every once in a while with realism that is scary. Like a bell sound out of nowhere that makes you jump out of your chair. Or how Miles' horn on *Live at the Blackhawk* cuts through the air like a flare. How could anyone not like this magical effect that I'm trying so uselessly to describe?

Since the *Moondog* is being offered in a package arrangement with Lowther Club of America, which I took to suggest a recommendation of the Lowther/*Moondog* combo, I had to try it with my PM6As in *Medallion* cabinets. Indeed, Welborne picked parts using his Lowther PM2As as one of his main reference speaks, so there ya go.

No shock then that the pairing really clicked, as expected. The *Moondog* supported the high-res well-lit effect of the paper cone Lowthers. The incisive midrange added realism where a more flabby mid would have steered the PM6As toward the boozy, lush flavor I got with a lot of my other SE triode amps on my Lowthers. There was something to be said for the tasteful restraint of the *Moondog* in this system configuration.

The *Moondog* also led me to rethink my theory that I really want some feedback on the Lowthers to add control the rear-loaded horn bass. Most no-FB SE amps I've tried on the Lowthers sounded gorgeous in many ways, but more often than not were underdamped in the bottom register.

However, to my amazement, the no-feedback *Moondog* played with excellent low end control, thanks only to the reasonably low damping factor provided by a naked 2A3. The tightness, definition, and punch were right there. Vibrations emanating from tightly-stretched membranes sounded like they were coming from tightly-stretched materials. Good job on the low end.

According to Welborne, most of the people who have been buying the *Moondog* kit own Altecs, Lowthers, or Klipschorns. The K-horn fans are particularly nirvana-stricken with the 2A3s, fitting since Paul Klipsch used Brook 2A3s back in the olden days.

Altec, Klipsch, etc....these are all obvious candidates, but I believe that the clear, crisp, and well-damped character of the *Moondog* would serve the amps well in the quest for matching speakers among the contemporary crop of audiophile boxes.

And if you find yourself in a situation where you think a bit more *whatever* is in order, remember that it's a kit. Feel free to screw around!

Comment

Obviously, I liked both 2A3 amplifiers that I heard quite a bit. Although I purchased the Fi "X" before ever hearing the Welborne *Moondog*, I was never stricken with buyer's remorse. Really, I would have felt the same way if I bought the *Moondogs*. Ahhh, 2A3 amps, I love 'em.These are the kind of amps I started building in order to enjoy. I'm really glad to see that you can go out and buy kits and amps like this now.

On sound alone, I could live with either amp, but with my Altec/TAD setup and system goal to build a funky blues/jazz oriented rig, the Fi amp is just the ticket for the job. Plus it fits on the mantle above my fireplace, an essential part of my babyproof scheme. Plus, plus, it is the coolest looking thing I ever saw and let's not underestimate *that*.

With compression drivers, I like a dash of romantic excess in the amp. These TAD 2001 drivers sure don't donate any romantic excess to the system. If I owned the *Moondogs*, I might try sticking in an oil coupling cap for compression driver use, although many would prefer the clean, low-distortion act of the stock amps. Tough to say.What I *think* I want isn't always what I *actually* want when it's playing there in front of me.

On the Lowthers, both amps again did a good job. The Fi 2A3 came across gutsy, rich, and punchy with a full, slightly puffy, and emotive bass. The *Moondog* shifted my attention upward in frequency to the ultra-clean midrange and sparkle effects but had

a low end that was surprisingly crisp and well-articulated for a NFB flea power amp on that rear-loaded bass horn.

Listening to these amps, it was hard to shift into an "amp shootout" review mode, because they both sounded so good in their own ways. I just wanted to sit back and listen to what the amps were doing.

SPEAKERS

Two of the big reasons 2A3 amps like the X and *Moondog* aren't more popular is that 1) Most people haven't heard anything like this and don't know how good it can be and 2) It does require a leap of faith to expect that there are speakers that 3W will drive. It is definitely difficult to believe, based on the usual preconceptions, that three watts will drive anything. All I can say is "ha,ha, ha."

I used to think I needed fifty watts *at least.* Now I can bridge the power outputs of my five favorite amps, and the total wouldn't even hit fifty, probably closer to forty, watts.

Obviously, 2A3 and 45 amps are tailor-made for what I like to use 'em for— efficient multi-amplified horn systems. Indeed, with a horn, power ain't nothing but a number, and you can totally ignore the specs and select amplification on the basis of musical performance criteria alone.

One reality we can never get beyond is that there is always a moment of mystery when you hook up a new amp and speaker combination. The challenge is a bit more obvious when the amp is a three-watter, since engineering feats like high-power and feedback are intended precisely to reduce the mystery of the speaker drive equation, and single 2A3 amps do it without those technical advantages.

On the other hand, at least the 2A3s are great sounding amps, which can't be said for many "drive-anything" amps, because what you have to do to "drive anything" is not free in terms of sonic tradeoffs.

It's easy to overplay the case that three watts is more useful than one would think, for these are indeed very low powered amplifiers that we're talking about. However, except for stupid combinations like Apogees or Magnepans + single 2A3s, I think that the quality and quantity of music that single 2A3s would put out on many "normal" speakers is worthy of respect. Three watts will get some sound out of any speaker, not to say that it would be anything great to hear in many cases.

As for specific speakers, well it either works or it doesn't. Only trying it will tell you if a 2A3 will play loud, play only at low-levels, or not at all on a given speaker. It would be nice if there were some specification that would tell us what we want to know, but there ain't no such thing, unfortunately

Speaker sensitivity helps but may not be important as highish (>8Ω) impedance and general voodoo synergism that applies to system matching. Simple or no crossover designs seem to work out a little better than lossy, complex networks, for obvious reasons, but anything is worth a shot because you never know.

Now that the speaker makers are hip to horns, isn't it time for the single-driver full range revival? Man, that's what we need! I still don't think I ever beat that pair of Altec 755A eight-inchers in 2 cu.ft. wall cabs that I had when I first started messing with low power. Lowthers are good but let's have something we can just stick into a plain old rectangular box and be done with it.

In various pockets of the globe, full-rangers like Diatones, Fostex, Supravox, Siemens, have their devotees, but the US scene never got hip to this classic low-intensity approach. True, single-cone drivers usually can't "do everything," but, for this kind of thing, it's more important how well they do what they do, mainly the mids.

The way *not* to try a 2A3 on a "regular" speaker, exactly the way most audiophiles would probably do it, is to pull out an old copy of *The Sheffield Drum Record* or "1812" and immediately crank the program up until the amp clips. Sure, it will clip. What did you think?

The right way to try out a low power amp with a "regular speaker" is to go ahead and listen to music as you ordinarily would and see how it works out. What usually happens is that it sounds pretty good, but while you're listening, dreams of horns start dancing in your head. What can I say?

It's strange that amp choice decisions are so often tied in with the speakers already in the listening room, when what we're doing is looking for a new AMP, right? Let's face it, a more productive system-building logic and more satisfying recipe for personal happiness would be to go out and buy the damn 2A3 amp *first* and *then* look for speakers that will work with the new amp. The truth. You heard it here first, fellas!

IN MEMORIAM
Koichi "Nobu" Shishido

Master Tube Experimenter



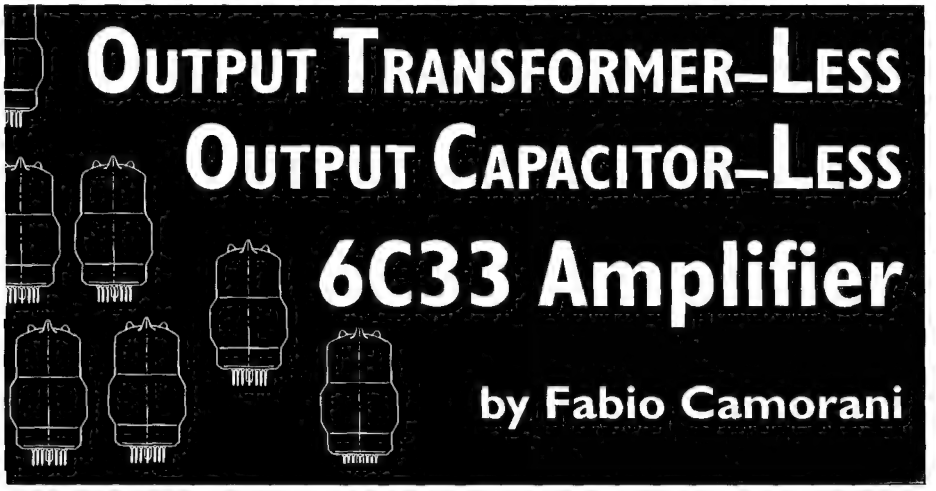
When I heard the sad news that Nobu Shishido died suddenly March 19th on the train home from an *MJ* Magazine party, I had his book open on my scanner, a fresh fax from him on my desk, and this 2A3 article in progress on my computer screen.

I wish that he could have read this article, not that he would learn anything new, but I thought he would get a kick out of seeing what he started many years ago, just like he always did. He was proud of his audio design work, but he seemed to especially relish his role as tube audio preacher.

Nobu was in chancy health for a number of years, but he spent his retirement working tirelessly to stretch the limits of tube audio design. Although best known in recent years for his Inverted Interstage Coupled transmitting tube designs, lately he seemed to consider his main work to be restoration of 78 recordings, even though he still loved tube amps like a little kid.

His last fax to me hinted at his experiments with the new Svetlana 572-3, joking that with the remarkable drive voltages required, "They must have been waiting for a genius like me to come along." I'll never learn what kind of wicked new driver stage he created this time, but like all the other stuff he did, it was probably one of those things that is perfectly obvious— once Nobu showed us how to do it.

The heroic missionary work begun by Nobu Shishido to tell the world about single-ended directly-heated triodes will surely continue in the power of his ideas. As an ex-advertising man, he enjoyed seeing the world gradually come around to his way of thinking. As a designer and DIY journalist, he participated in building the audio world he wanted to live in. As a friend and teacher, he will be missed by all of us who knew him. *Joe Roberts*



Output Transformer–Less Output Capacitor–Less 6C33 Amplifier

by Fabio Camorani

Less is MORE!!

Output transformerless amplifiers have always excited admiration and also devotion in audiophiles. These amps have always been under "special observation" and seemingly always on the verge of revealing themselves as the best product of the field. However, in practice, they have never been considered totally convincing. What are the true limits of such amps?

Mirko Bersani and I tried to find an answer designing a very special OTL tube amp during 1993, a quasi-single ended OTL tube amp. In effect we went behind every previous OTL design. But we thought more and more could be done. And I did more during the following years, thinking about several limits in our original design. When two Italian audiophiles asked me to design custom versions for their systems a great evolution of the original design began.

Here I present those two versions, intermediate steps through the final (?) mono monsters which are the objects of my thesis.

INTRODUCING THE CIRCUIT

The origin of this OTL typology was fully described in *Costruire Hi-fi* during 1994/95 (#s 10-11-12-14). Here I write only a few things. First of all, in these two amps there is no feedback, neither global nor local. This is possible above all because they were designed for special and well-defined applications. In "general purpose" amps where the load is an unknown there may be some problems with no NFB OTL tube output stages.

Then, notice that they are two-stage designs, the simplest OTL tube amps I have ever seen. This is possible because they are not push-pull but, using an SRPP as output stage, we may call them "quasi single-ended" OTL-OCL tube amplifiers.

In effect, the true limit of all push-pull designs is the phase splitter stage, always imperfect even if very sophisticated. And the SEPP is an asymmetrical push-pull stage. The only splitter stage with absolute sound performances is the transformer but I specified the use of no transformer at all (1).

Again, the SEPP stage needs feedback to balance the signals (gain and impedance). So, Mirko Bersani and I searched for a solution finding the SRPP as the natural choice for the job. Stephens used this typology (with 2A3) for the first time back in the 1950s to drive a special 500Ω speaker.

Later Philips used this circuit with EL86 (pentodes) with an output impedance around 1000 ohms (headphones). Other famous examples are the OTL amps developed for direct driving of electrostatic loudspeakers, like the one for Acoustat X (with pentodes).

However, my amps have a lower impedance output stage which is able to supply remarkable currents and to drive more conventional loudspeakers. Some time ago, the famous Japanese magazine *MJ* presented an amp with a SRPP output stage made with a 6080 coupled through a cap to an autotransformer (obtaining a few watts). Speaking with Ken Ishiwata-san at the Top Audio 1994, I learned that something similar to this design was published in Japan circa 20 years ago, then nothing more.

THE OUTPUT STAGE

Pentodes are not devices for audio, but they are very good for other applications. So we consider only pure triodes or triode-connected pentodes in this design.

The most useful pentodes are the ones originally used as sweep amplifiers in old television circuits. Such devices have high current capability and low internal impedance but they are not very linear and, since they were developed to dissipate impulsive power, they don't live a long time as output devices running in Class A. Maybe the new Svetlana EL509 is the ticket? It looks to be developed for linear circuits and it has a monster cathode.

Then...triodes. What triode? The most common and interesting tubes for our purpose are the ones from USA developed for series regulated power supplies, almost all with octal base, such as 5998, 6AS7G, 6080 (also WA,WB,WC), 6082, 6336 A/B and 6528, Sylvania 7241, or the deranging Sylvania 7026R. Or the 11A3 Mullard and the Soviet EC19P.

But the output stage reaches the highest level of performance only with the monster Russian triode known as 6C33C-B—although the correct Cyrillic name is 6S33S-V. (2).

THE INPUT STAGE

Even though the output stage is greatly responsible for the performance of the amplifier, the real cornerstone of the design is the input/driver stage. This is crucial and very critical. A stage can be designed only knowing what it has to drive. Some goals may be in discrepancy with other goals. The designer has to select the best choices based on listening tests (obvious?).

This input/driver stage must have some particular characteristics. Our choice of SRPP may not be obvious, so let us explain:

Low output impedance:

In general, a driver must have low output impedance for a better drive capability. The 6C33 has a very high input capacitance and near clipping is critical (its grid needs current).

Good slew rate:

The slew rate should be neither astronomical nor infinitesimal (research and published measurements show music slew rate rarely exceeds 1V/s, nor is ever more than 2V/s and is usually under 0.2V/s).

Linearity:

We must adjust the bias to have a low number of distortion harmonics (possibly only the second and the third ones for the whole voltage swing). One can try to have harmonic cancellation with one's particular loudspeakers. However, I do not think it's a very good idea.

Starting from these points, Mirko and I tried some circuits. And we saw that only SRPP reaches the goals. We tried the mu-follower as well. This circuit is the natural evolution of the SRPP and has been described elsewhere (*Glass Audio* #2-1993, #2-1991, TAA #3-1991 and elsewhere). It first appeared in '50s.

The mu follower circuit apparently has no technical defects to argue against it, but we tried it and do not like it so much. We used and continue to prefer SRPP drivers with a very high power supply voltage.

THE POWER SUPPLY

OTL power amplifiers are, probably, the most sensitive ones to power supply quality because of the unfavorable relation between the power supply impedance and the internal impedance of the amp, among other reasons.

A dual "floating" power supply is typically used with excellent results. In this particular design the reference point for the load is between the filter caps: this point is floating so there is no dangerous DC voltage through the load. Only turning on the amp you have DC voltage in the output, that is during the charge-up of the filter caps.

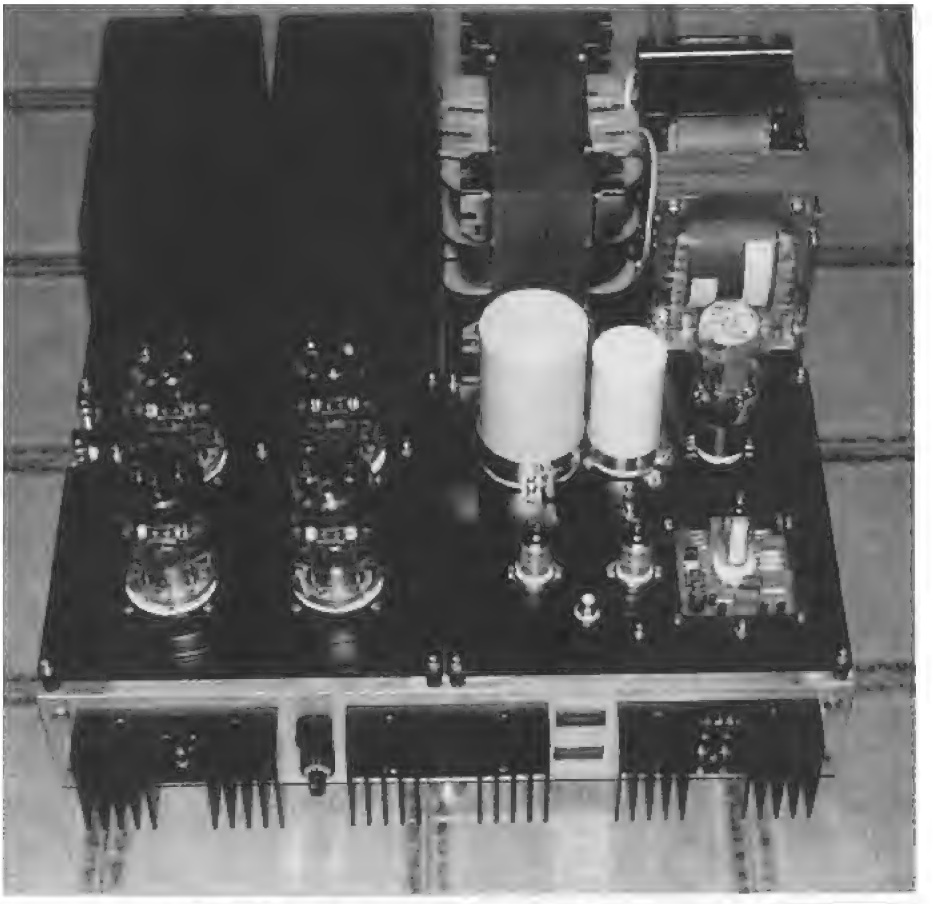
This system compensates for the natural aging of the tubes so you can use your amp for a bit more time between retubings. One would think that in so-called OCL amps there are no caps through the signal path, but this is not true. This is not a new subject, but a lot of manufacturers go on telling the opposite. The current needed by the upper tube (or bipolar transistor, or mosfet, or...) is supplied only by the caps in the positive rail and the current through the lower tube by the caps in the negative rail. So, the capacitors are in series to the signal, without a doubt. There is no commercial design without caps through the signal path!!!

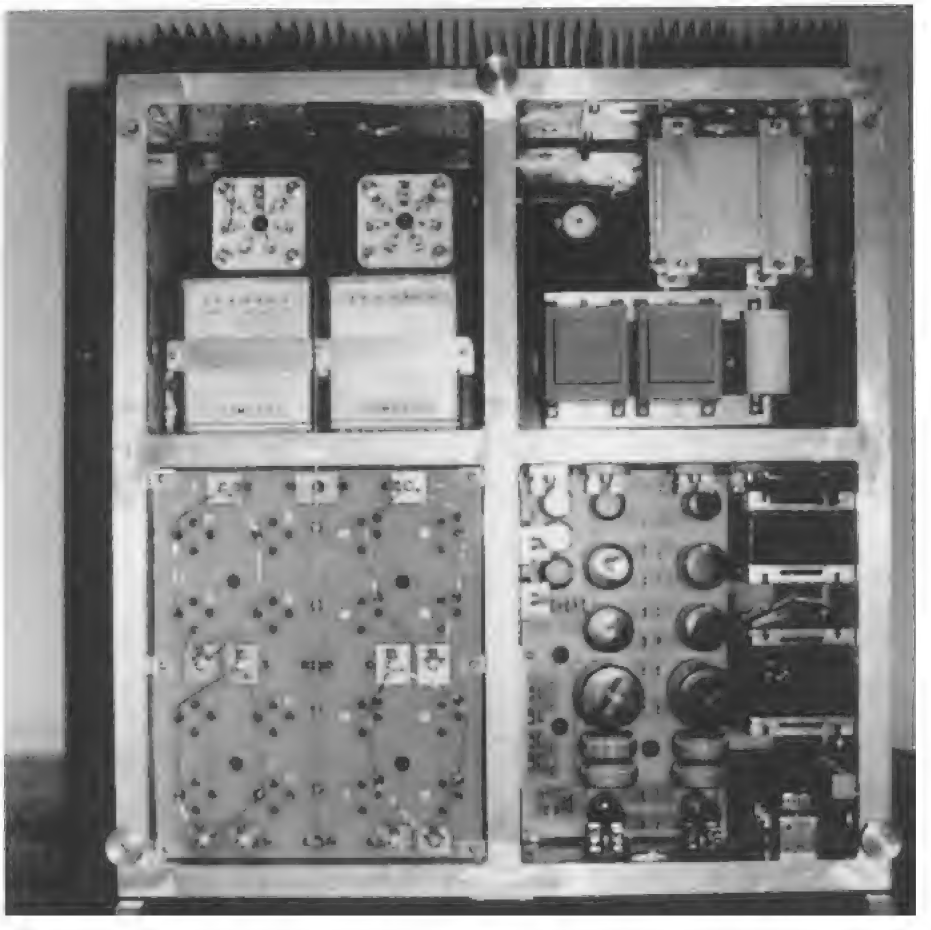
Again, a floating power supply has not only pros but also cons. The generators are in series each other, as well as the caps seen by the generators. In this case, the influence of filter caps is higher so the power supply has an even greater impact on the final sound.

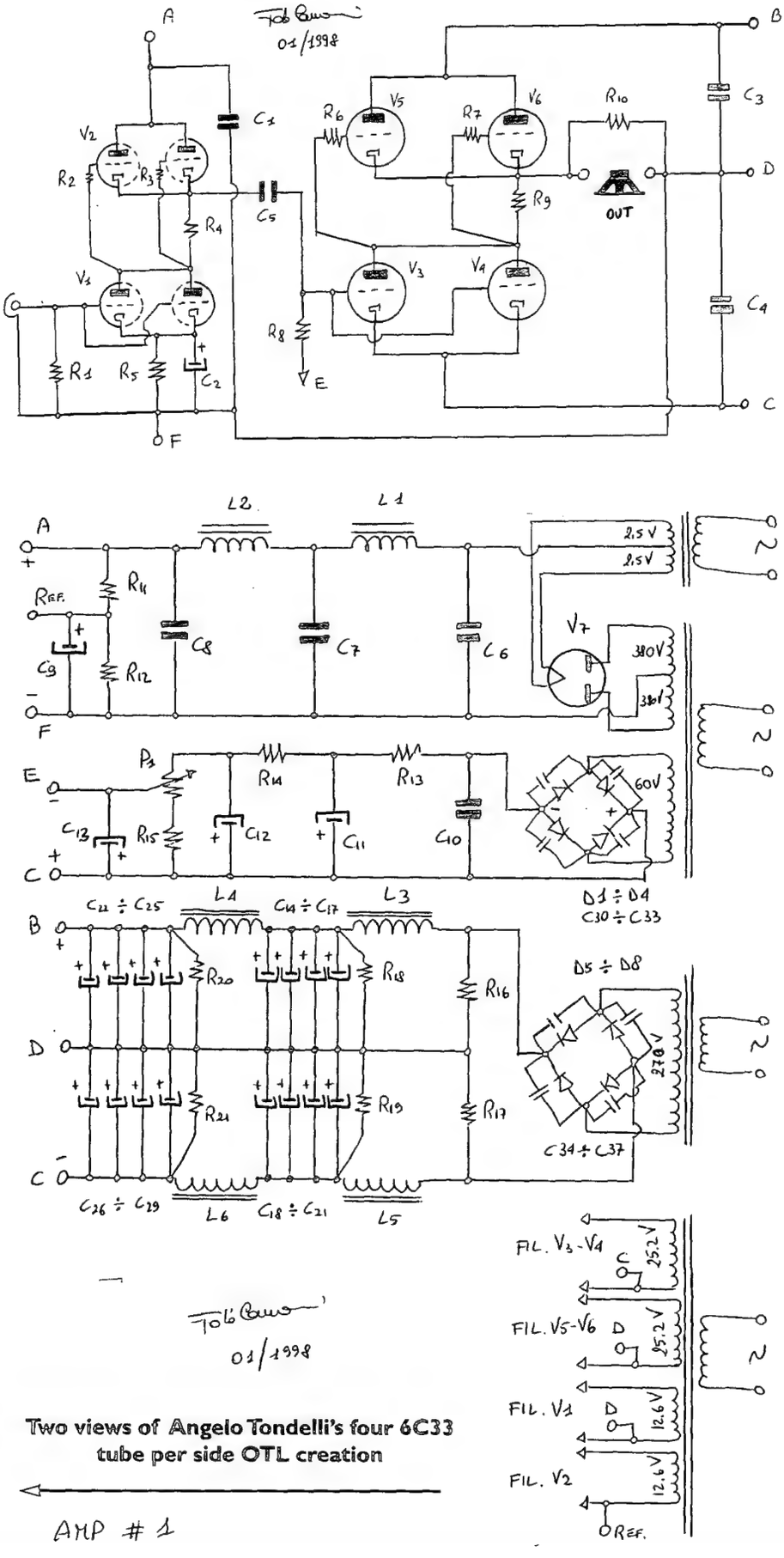
MORE ON SCHEMATICS AND COMPONENTS

Amp #1 has 4 output tubes per channel and was designed to drive a Quad ESL 63 electrostatic loudspeaker. The schematic is still very simple with a double SRPP as input/driver stage realized with two 5814A Sylvania, selected after some listening tests.

However, the power supply is very complex. The one of the output tubes has a double LC filter per rail, with choke input, and the diodes are soft recovery devices from IR. The







Two views of Angelo Tondelli's four 6C33 tube per side OTL creation

Amp #1

R1	220k	1W	Holco
R2-R3	220	1W	Allen Bradley
R4-R5	1k5	2W	Caddock MS220
R6-R7	220	1W	Allen Bradley
R8	47k	1W	Holco
R9	22	50W	Caddock MP850
R10	1k	2W	Caddock MS220
R11-12	150k	2W	carbon
R13-14	4k7	0.5W	carbon
R15	2k	1W	Holco
R16/R21	33k	2W	wire-wound
P1	10k	pot.	multiturn
C1,C3,C4	12uF	600V	paper in oil
C2	100uF	35V	Black Gate
C5	.47uF	630V	AudioNote cop.
C6	5uF	600V	MKP
C7	50uF	800V	MKP
C8	140uF	630V	MKP
C9	10uF	450V	electrolytic
C10	68uF	400V	MKP
C11-12	220uF	200V	electrolytic
C13	22uF	160V	ROE electrolytic
C14/C29	1000uF	250V	Philips electro.
C30/C37	0.01uF	1kV	ceramic
L1-L2	10Hy	50mA	300 ohm
L3/L6	2Hy	1.5A	4 ohm
D1/D4	1A	1000V	UF4004
D5/D8	16A	1200V	IR-HFA16PB120
V1-V2	5814A		Sylvania
V3/V6	6C33C-B		Sovtek
V7	5R4GY		Fivre

more common double pi-filter is used in the power supply of the input stage.

The builder of this amp, Mr. Angelo Tondelli, performed a lot of listening tests choosing the best components for every stage. So you can see the amp uses Holco and Caddock resistors, Black Gate and Philips caps, Audio Note copper foil paper-in-oil cap as coupling capacitor. One can use an incredible and expensive ICAR device born for aerospace applications, the ICAR SP25, but it's not so easy to find (it's big too!).

Mirko Bersani and I made a special cap for the first version of the amp (published in CHF), a pure mica/pure copper capacitor using a structure arranged in layers. We still use them in some projects. Mr. Tondelli found AN oil/paper is better in his case. He was working on this project for two years. He claims that he has never heard better amps than these, including the usual high priced high-end ones.

He biased the amp so that he measures around 110-115V across the lower tubes and 90-95V across the upper tubes. This way the amp has circa 20W of max output power with a load of 8 ohms. Feel free to try different working points, adjusting them to your loudspeakers.

Mr. Tondelli used a 7812 three-terminal regulator (not in the schematic) to regulate the filament supplies for 5814As for problems with hum. He is planning to try 6SN7 double triodes, well known and much better than any 5814As or equivalent, especially if by Fivre or Sicte. He is planning to improve the performances by adding more Philips electrolytic caps in the output tubes' power supply.

Amp #2 has six power tubes per channel. The builder, Mr. Giuseppe Intorrella, wanted a bit more power to drive Sonus Faber and Magneplanar loudspeakers. I think a six-tube output stage is, in general, the best compromise with this particular OTL design, offering good interface to the load.

In this case, the driver is more critical because there are three grids to drive. We chose the 5687WB double triode and SP25 oil caps (he used Mallory PCB first). Mr. Intorrella chose to use only one CLC filter (pi-filter) in the power supply due to space problems. The components are again from Caddock, Black gate, Philips, IR etc..

Mr. Intorrella designed and built a circuit with microprocessor control for the full amp. With 6 tubes he can easily obtain 30W output, but he chose to run each tube at 40W plate dissipation, a very conservative level, for a measured output of 24W. It took almost two years to finish the pair of monoblocks.

These amps have a very high power supply voltage for the input/driver stage, as mentioned. Both 5687WB and 5814A work very well at high voltages. I chose 450-500V (meaning 225-250V across each tube in the SRPP circuit).

Both amps use fixed bias for the output stage, very strange for an SRPP circuit. Because the upper tubes have a fixed resistor, you have to bias the lower tubes for almost equal voltages between anode and cathode of both upper and lower tubes, circa 400mA per tube. Notice the references for the filament supplies.

Regarding the life of the 6C33C-B power triodes, if used well below their limits (say 75-80% of max power dissipation), I think we can count on at least several thousand hours.

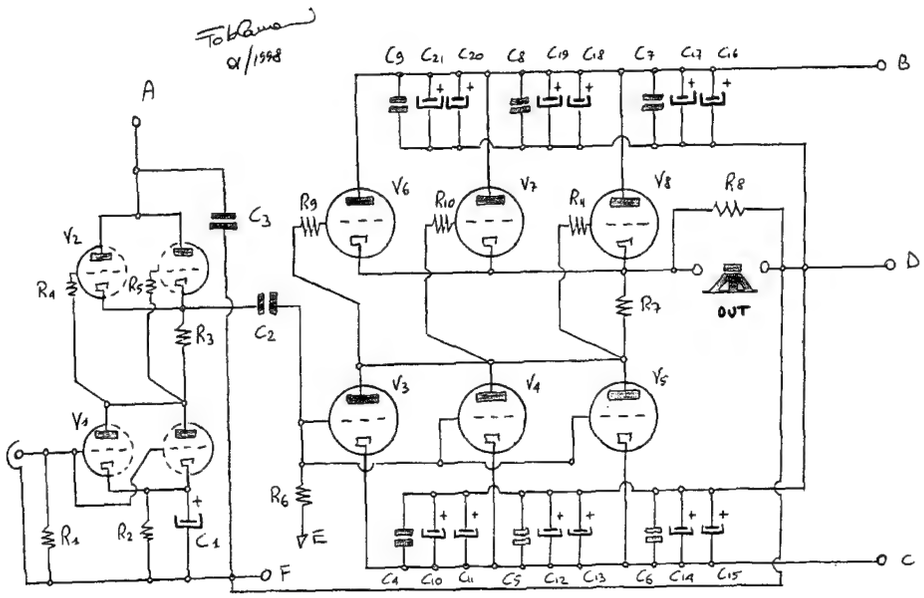
CONCLUSIONS

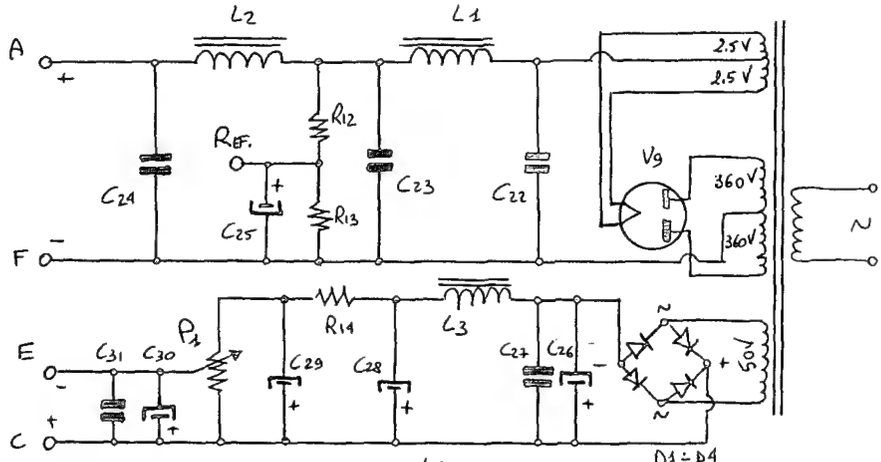
In conclusion, I think these are very successful designs, reminiscent of the typical monotriode sound. Obviously, efficiency is not the goal of

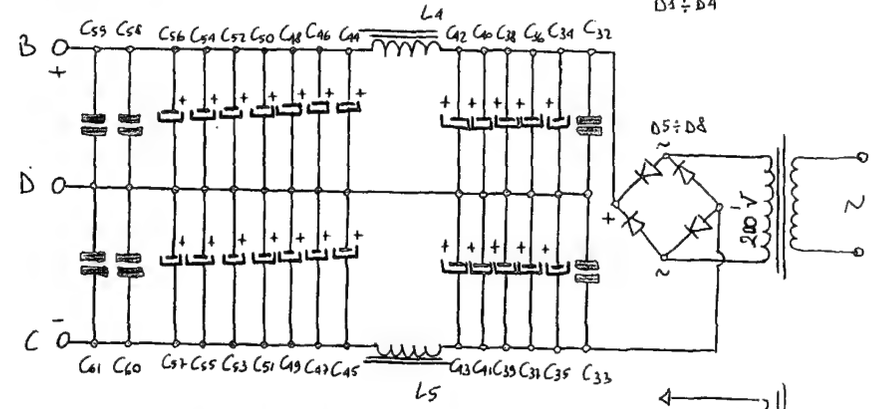


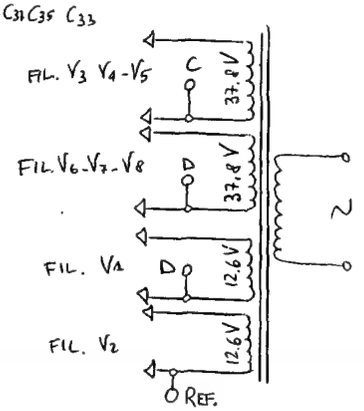


Giuseppe Intorella's fabulous six-tube per side 6C33 OTL monos, two years in the making, feature the ultimate modern refinement of microprocessor control!









Costruire Hi-Fi Ordering Information
Italy's Leading DIY Journal

Europe $62 Surface / $75 Air
Overseas $95 Airmail
Oceania $105
Back Issues $9.50 each
Special package deal: on back issues:
Issues 1-20 $120

Mozart Editrice,
Voc La Castagna
05024 Giove (Terni) ITALY

Amp #2

R1	220k	0.5W	Holco
R2-R3	470	1W	Holco
R4-R5	1k	0.5W	Holco
R6	47k	1W	Holco
R7	15	50W	Caddock MP850
R8	1k	2W	Caddock MS220
R9/R11	1k	0.5W	Holco
R12-13	100k	1W	carbon
R14	8k2	1W	carbon
P1	15k	pot.	multiturn
C1	220uF	35V	Black Gate
C2	2uF	600V	ICAR SP25
C3/C9	12uF	600V	paper in oil
C10/C21	1000uF	250V	Philips electro.
C22	50uF	800V	MKP
C23-C24	140uF	630V	MKP
C25-C26	100uF	385V	ROE electrolytic
C27	0.22uF	250V	MKP
C28-C29	220uF	250V	electrolytic
C30	10uF	160V	ROE electrolytic
C31	0.1uF	250V	MKP
C32-C33	12uF	600V	paper in oil
L1-L2	10Hy	50mA	350 ohm
L3	20Hy	20mA	450 ohm
L4-L5	2Hy	2A	4 ohm
D1/D4	1A	1000V	IN4007
D5/D8	16A	1200V	IR-HFA16PB120
V1-V2	5687WB		Sylvania
V3/V8	6C33C-B		Sovtek
V9	5U4G		Sovtek

my OTL designs. Everything is used only for best results.

According with the purpose of this magazine, I presented schematics needing some "practices," some adjustments, leaving the experienced readers free to try. Even negative feedback, if they think...

I think the best possible use is with horns, with no doubts, perhaps 16 ohms devices for better power transfer. Obvious, maybe, but this is not true for every OTL. Most standard OTL designs really show their musical limits driving horns!

Acknowledgments:
I would like to thank Massimiliano Morini for help with the translation and editing.

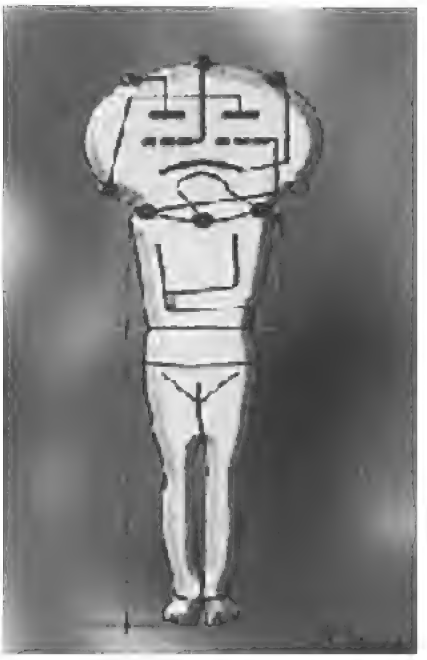
1— I do not think that the transformer is a sort of electronic devil. I even like fully transformer coupled tube amps, however I wanted (and want) to investigate the true limits of tube design without transformers.

2— For a complete report on 6C33C-B power triode, you can see the article published by the author in *Costriure Hi-Fi* n.25 December 1996.

Hello, "Darling"

A 1626 Triode Single-Ended Stereo Amp

by Bob Danielak



3/4 watts of CHEAP FUN!

Introduction

I've been doing tube amps for some time now (over 15 years if you count guitar amps). Over the past several years I've gravitated more and more toward designing/building "HI-FI" type equipment. At the risk of sounding like I'm jumping on the bandwagon, my main interest these days is in relatively low power Single Ended Triode amplifiers.

However, now that these types of amplifiers are practically "mainstream," I may sometimes purposely avoid otherwise great sounding tubes and circuits because others have already "been there - done that". The high price of most popular Directly Heated Triodes and quality output transformers is also an inducement to stay off the main road.

Luckily, if he keeps an open mind, with a little research, experimenting, and junkbox digging the avid DIY'er can end up with a very satisfying piece of equipment and still pay his mortgage.

About the 1626

Okay. The 1626 is *not* a directly heated triode (DHT). It is an indirectly heated power triode originally used in low power RF amps. It is not the most linear of triodes, and its plate is only rated for about 250V/25mA. Another mild pain is that it requires a 12.6V filament supply (there's no 6.3V connection option). Amplification Factor is about 5. Plate resistance is around 2K.

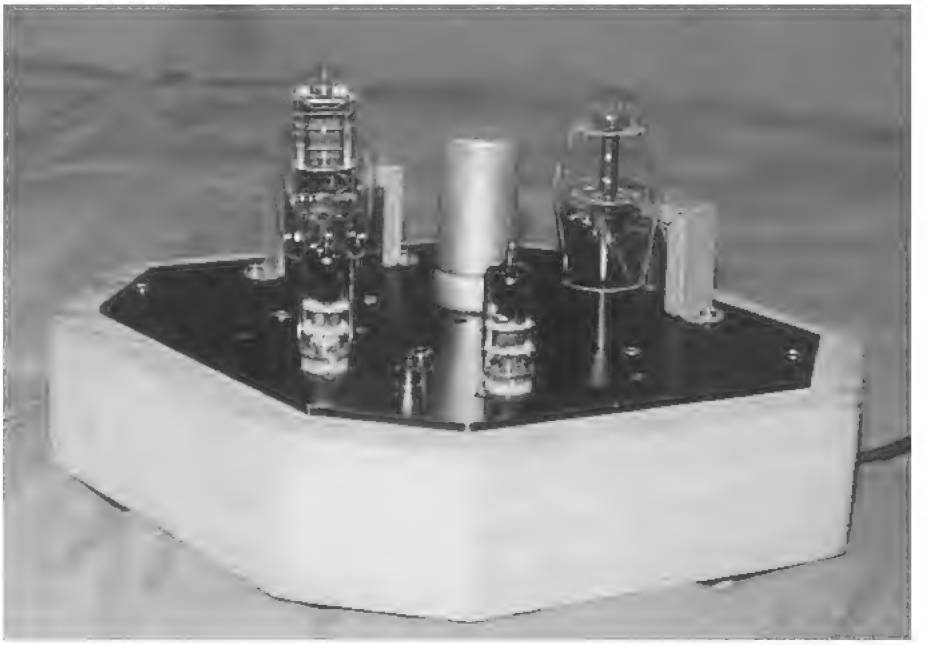
On paper, the 1626 would not appear to be very promising for a Class A audio amp. What really attracted me to this tube, however, was its cute ST-12 shaped bottle. So I picked a few out of a pile of old tubes at some surplus joint for $2.50 a pop. I was thinking about doing a funky line stage with them.

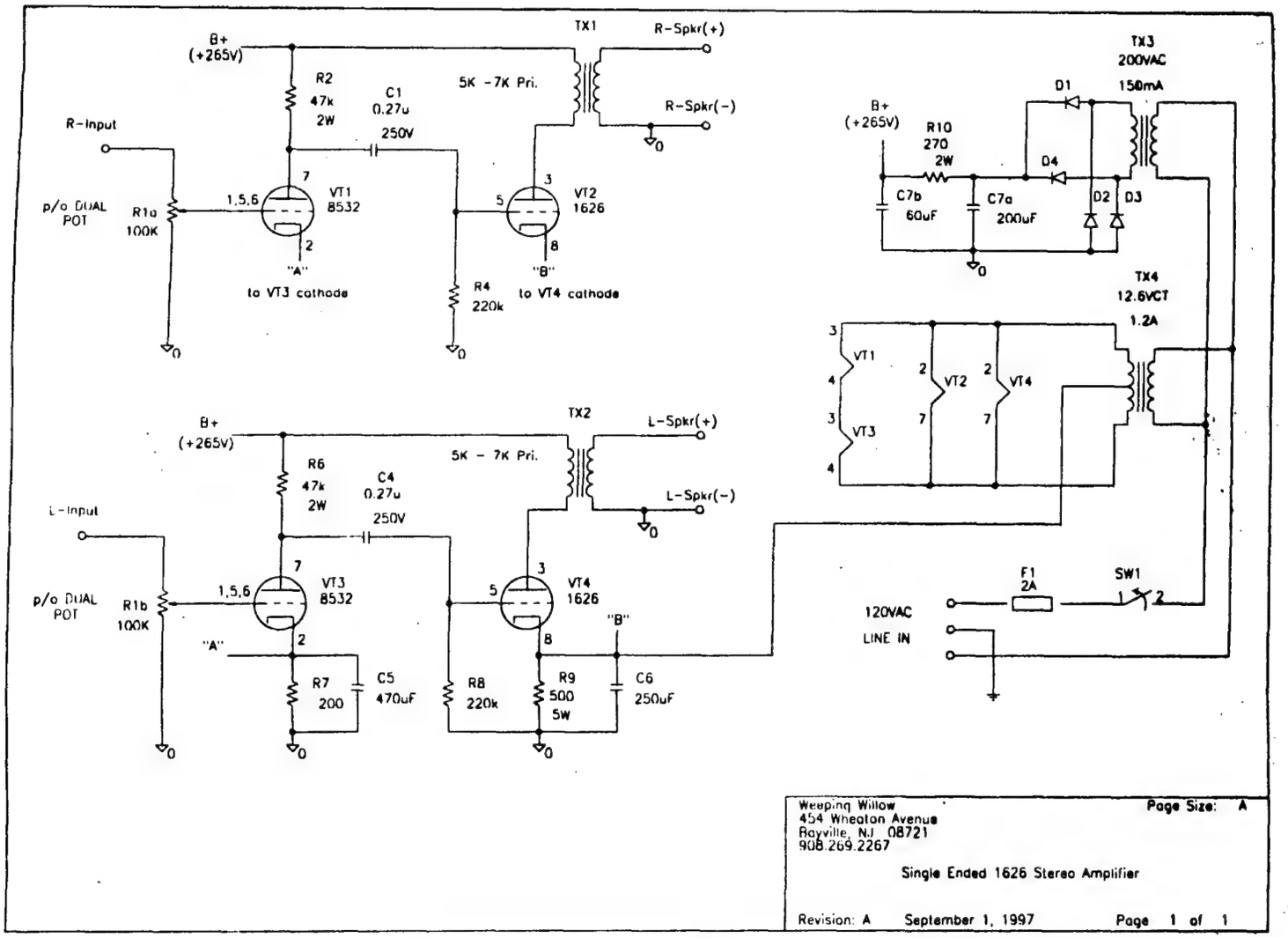
Of course they sat on a shelf for a while as I worked on several other projects. One of these projects just happened to be a SE 12V6 stereo amp using a 12SJ7 pentode driver. Somehow, I figured out that the pinout of the 1626 is basically the same as the 12V6 minus the screen connection. So I just dusted off the 1626's and plugged them in.

I was pleasantly surprised with both the sound quality and with the apparent volume I achieved with only 3/4 watt of power. At this point I decided to devote some time to find a good driver for the 1626. Driving the 1626 is not as tricky as it is with other triodes such as the 2A3, 45, or 71A. Biased near its maximum ratings, we only need about 25 to 28V, peak grid voltage. The 1626's input capacitance is also rather low for a triode (around 30pF including Miller Effect). This means we don't need a super-high-current driver.

Any designer worth his salt ought to be able to bark out a dozen worthy candidates for this job. A gain of 20–30, drawing a couple of mA....easy, right?! The biggest problem was that there were too many choices!

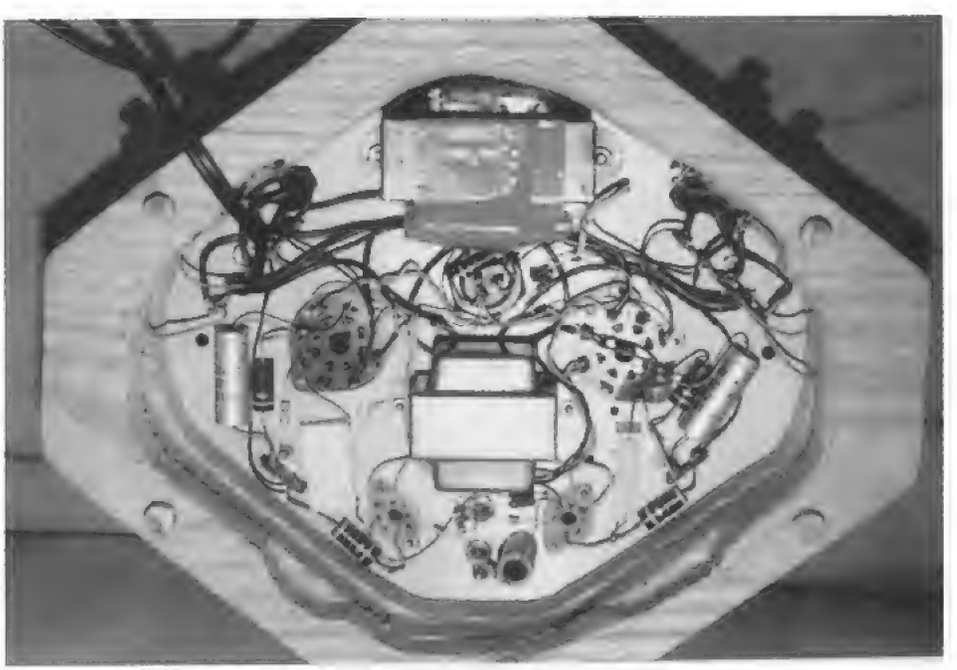
Before settling on any one driver I tried a whole slew of tubes/topologies. Just to name a few in descending order of preference: SRPP 12SL7, 12SJ7 pentode, SRPP 12SN7, simple plate loaded 12SL7, Parallel 12SL7, etc, etc.... I never got around to some of my favorite 9-pin triodes like the 12AY7 or 5965/12AV7. I have a feeling that the 5965 would be a good match for this application.





The driver that I eventually fell in love with is shown in Figure 1. It is a simple plate loaded gain stage using the 7-pin miniature high frequency triode, 8532, a ruggedized version of the commercial type 6J4. It has a mu of about 52 and a gm of about 11,000 uS. It biases up nicely for this application at its maximum plate voltage of 150V, drawing about 3-4mA with a bias of about -2V. This stage gives me a gain of about 32, resulting in an input sensitivity of less than 1V peak, with over 1V of signal headroom.

Higher plate current can be used, but this cuts into input headroom and output swing. Another novelty of the 8532 was its size. It seemed to fit nicely with the "miniature" theme. As you'll see in Photo 1, the finished amp looks like a 1/2 Scale version of a stereo 2A3 or 300B amp. Darling, isn't it?



1626

1626
TRANSMITTING TRIODE

For oscillator applications requiring unusually stable characteristics

Heater°	Coated Unipotential Cathode	
Voltage	12.6	a-c or d-c volts
Current	0.25	amp.
Amplification Factor	5	
Direct Interelectrode Capacitances:		
Grid to Plate	4.4	μμf
Grid to Cathode	3.2	μμf
Plate to Cathode	3.4	μμf
Maximum Overall Length		4-1/8"
Maximum Seated Height		3-9/16"
Maximum Diameter		1-9/16"
Bulb		ST-12
Base	Small Shell Octal 8-Pin, MICANOL#	

MAXIMUM CCS RATINGS and TYPICAL OPERATING CONDITIONS

CCS = Continuous Commercial Service

R-F POWER AMPLIFIER & OSCILLATOR - Class C Telegraphy

Key-down conditions per tube without modulation ØØ

D-C Plate Voltage	250 max.	volts
D-C Grid Voltage	-150 max.	volts
D-C Plate Current	25 max.	ma.
D-C Grid Current	8 max.	ma.
Plate Input	6.25 max.	watts
Plate Dissipation	5 max.	watts
Typical Operation:		
D-C Plate Voltage	250	volts
D-C Grid Voltage*	-70	volts
	14000	ohms
	2300	ohms
Peak R-F Grid Voltage	105	volts
D-C Plate Current	25	ma.
D-C Grid Current**	5	approx. ma.
Driving Power**	0.5	approx. watt
Power Output	4	approx. watts

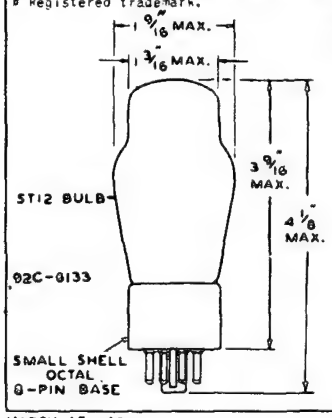
° In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.

ØØ Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

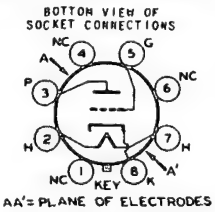
* Obtained from fixed supply (-70), by grid resistor (14000), or cathode resistor (233), or by combination methods. When the 1626 is used in the final amplifier or a preceding stage of a transmitter designed for break-in operation and oscillator keying, a small amount of fixed bias must be used to maintain the plate current at a low value. With plate volts of 250, a fixed bias of at least -35 volts must be used.

** Subject to wide variations as explained on sheet TRANS. TUBE RATINGS.

Registered trademark.



Data on operating frequencies for the 1626 are given on the sheet TRANS. TUBE RATINGS vs FREQUENCY.



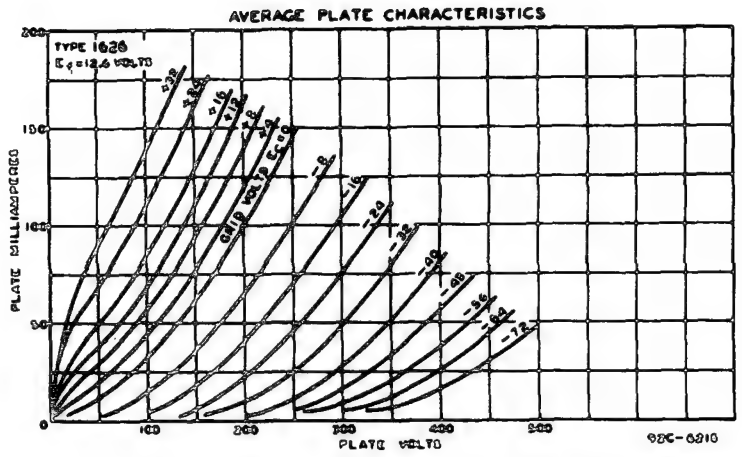
AA' = PLANE OF ELECTRODES

Pin 1 - No Connection
Pin 2 - Heater
Pin 3 - Plate
Pin 4 - No Connection
Pin 5 - Grid
Pin 6 - No Connection
Pin 7 - Heater
Pin 8 - Cathode

TUBE MOUNTING POSITION
VERTICAL or HORIZONTAL

MARCH 15, 1941 TENTATIVE DATA

RCA RADIOTRON DIVISION
RCA MANUFACTURING COMPANY, INC.



Cutting Corners

I guess you could call this amp a study in minimalism: a single 1626 driven by a single 8532 per channel all fed from a common B+ supply. Then, pushing the envelope even further, I called upon a trick sometimes used by commercial stereo manufacturers to reduce parts count and unit cost.

Rather than using separate cathode resistors and bypass caps for each channel, some designs shared the cathode resistor and bypass cap between Left and Right channels. Although I've only seen this done in the output stage, I extended this technique to include the input stage cathodes as well.

Fundamentally, this should work just fine. After all, the bypass cap is essentially an ac short. One short - Two shorts, what's the difference?!! Half the cathode resistance, double the capacitance and you're done...Of course, the bypass cap is not a perfect short. At low frequencies its impedance naturally begins to rise. And then there are the effects of ESR and ESL (which will cause an impedance rise at higher frequencies).At worst, this could cause some degree of mixing of left and right signals in each channel. So for a normal stereo input you might expect some crazy phase cancellation effects.

At best, this small degree of "mixing" might be similar to some of those fancy "matrix" enhanced stereo effects found in "room simulators" or early synthetic stereo surround sound systems. In fact, it might actually explain the extraordinarily wide image that this little amp presents.

However, for the range of frequencies that we are normally interested in, these effects should be negligible. I have tried both shared and separate cathode circuit elements in this amp. Couldn't really tell a difference....Perhaps another benefit of this approach is that you can now afford to use one good quality bypass cap(Cerafine, Black Gates, etc.) instead of two mediocre ones.

Construction: Cutting More Corners

As you can see in the photos, shape I chose is rather unusual. The aluminum top plate began its life as an 8" x 10" rectangle. Then the corners were lopped off creating a sort of eight-sided diamond shape. Tubes, Output Transformers, and a can-style dual filter cap are mounted on deck while the small power transformer and separate 12.6 VCT filament transformer are mounted below.

The base was made by laminating three 8" x 10" x 3/4" oak boards and cutting out the middle. Oak was chosen for this approach because it is the only wood that has a decent looking end-grain. Previous attempts at a mitered vertical maple base proved very frustrating. The solid oak approach makes for a much sturdier base, and it fit in better with my home decor, anyway!

The view of the undercarriage shows how much room I had to work with. The worst thing about this layout is the proximity of the filament tranny to the input tubes. I do get a slight bit of hum, as a result. With my speakers (90dB/w/m, Design Acoustic PS-10's) hum is barely audible. Through a friend's (Dave Slagle) "Big-Fun" Lowthers, the hum was more noticeable, but it was soon forgotten about once the music started.

In later versions of the "Darling", I used an 8" x 12" footprint. Moving the filament tranny to the opposite end of the chassis practically eliminated the hum. Another trick that helps reduce heater-induced hum is connecting the filament winding center-tap to a positive potential. This is most conveniently provided by the output stage cathode.

Wrap-up

To quote a friend, " this amp has no right to

sound as good as it does." The design is nothing special. No rocket science (my day job) employed. No fancy parts were used in the original. But perhaps it is the simplicity of the design that makes it sound the way it does. I'm guessing that I may have lucked into a "synergy" between the 8532 and 1626.

Individually, their characteristics are seemingly "less than optimal" (both create a lot of 2nd harmonic distortion). But together, at the chosen operating points, they seem to complement each other very well. I still haven't figured out why this amp should sound so good, but when I do, I'm going to bottle it!





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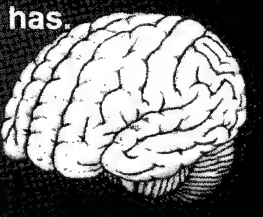
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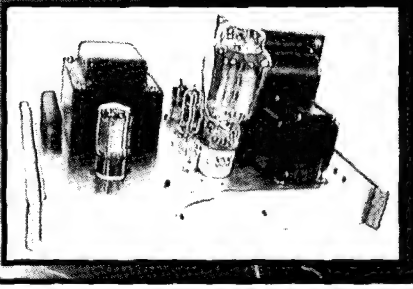
Not too many times does lightning hit an industry like single-ended triodes has. But there are still some reviewers and consumers who feel that SE just does not have the power for most speakers. Well here is some information for the right side of your brain that your left side has been saying all the time.



listen to your left side of your brain

We listen typically at 84dB's in our listening chair at say 6.5 feet (2M) centered on our speakers. The SPL at 1M away to make 84dB at the chair is only 89dB. So if we have a 89dB efficient speaker at one watt we would have a comfortable output. This leaves us with a ton of options considering most of the SE amps are 8W or better to deliver ample transient information.

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The 210 Split

Domesticating the Giant Altec 210 Bass Cabinet

by Michael Frye

If you can domesticate the 210, you're pretty good at that kind of work

The Altec VOT A5 and later A7 system using the 825 and 828 enclosures have been featured in a number of excellent articles in the pages of *Sound Practices*. A few of the modification suggestions to the enclosures have been straightforward and have enabled me to get much more from the upgraded boxes.

Changing woofers has also made some difference. The 803A with its thin straight wall cone and higher (40-50 Hz) resonance offered improvement in the lower mids while the 515 with its lower cone resonance and larger magnet seemed to improve the mid-bass output and snap somewhat.

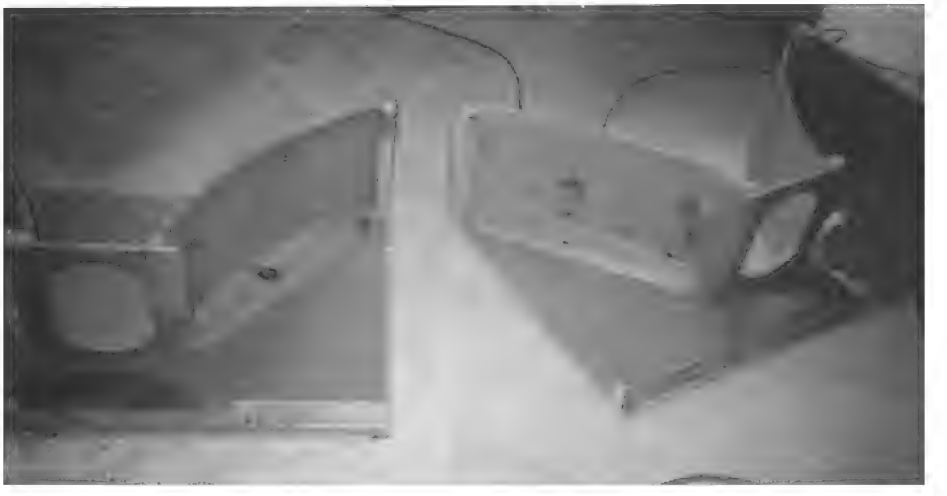
I speculated that better bass extension, improved bass and midrange clarity, and the elusive quality of articulation and detail might be more easily realized using a full bass horn design. It seemed to me that a longer bass horn with its lower horn cut off would be a choice worthy of exploration.

Fortunately, I had access to a large number of Altec's big 210 bass horn enclosures and more than enough Minneapolis cold weather shut-in time to experiment.



Above—Even without "wings," the 210 cabinet is a giant at 84" tall

Right—210 bass horn bisected on the workshop floor.



In particular, bracing and damping suggestions improved the VOT system's definition in the lower mids and upper bass and make an otherwise excellent loudspeaker better. Any change to tame the stock crossover has to be an improvement and several suggestions (issues #2 and #11) are worthy of consideration.

ALTEC 210 HORN DESCRIPTION

The 210 bass cabinet is clearly built for the auditorium. Its physical dimensions measure 84 H x 34 W x 39.5 D. These dimensions are so unruly for home use that about the only door through which it can be maneuvered is a wide front door or a large patio door. Most interior doorways are 30 or 32 inches, so unless one has a very large foyer that serves as a listening room, this behemoth is not going to work.

However, the Altec 210 has the potential to produce better articulation and a deeper, smoother, more continuous response than its smaller sibling, the A5 bass enclosure. In part, this is due to the bass horn's nominally lower free air cut off frequency (70 Hz versus 180 Hz). This free air response is going to be quite a bit lower in a listening room because among other things coupling the enclosure to the floor in the right places within a room may give perhaps another octave (35 Hz) of range. I later found out that usable bass output in my room extends even lower.

The stock cabinet takes two 15 inch woofers per side. Loaded with a pair of Altec 515 woofers, it should produce about 110 db/1 watt/1meter given Altec's 104 dB rating for a single 515 without horn loading. Like the 825/828 cabinet the 210 has an approximately 2 foot high port area

beneath the bass horn. In contrast with the 825/828 horn, the non flared sides of the 210 horn are parallel. (The two non-flared sides of the very early 825 cabinets were parallel.) These sides in the 210 are 5 feet in length at the mouth of the horn. All in all, this is one impressive looking horn!

DOMESTICATING THE 210

The kernel of the idea to tame this giant for use in a home listening room derived in part from the design of the JBL 4550 cabinet. The JBL is a dual woofer design along the lines of the 210, but it is a full horn load and is claimed to have usable response to 50 Hz in JBL's literature. Compared with the 210, the 4550's dimensions seem almost manageable at 60" H x 36" W x 32.5"D. Although the 4550 doesn't pass the doorway test either, it is physically smaller because it lacks the two foot port section found on the 210.

My solution for the 210 was to cut off the two foot port a la the JBL 4450 and, since the saw would already be out, cut the enclosure in a vertical line, right down the center.

In the process of creating an enclosure that met the doorway test, cutting the enclosure halved the number of woofers one would need for a stereo pair. After the cuts were made, new plywood was cut, glued, and screwed to create new bottoms and sides.

The result is visually quite stunning (at least to a horn aficionado). With its 17.75" x 39.5" footprint it occupies slightly less floor area the standard A7/A5 and is just 18 inches taller. The surgery had reduced the footprint by half but also reduced the total volume to less than 37% of its original size, while maintaining the original horn geometry.

The clean, sweeping curves of the horn flares and the slim frontal aspect makes for a modern, elegant looking enclosure. Looking into that 5 foot vertical horn mouth made me want to load it up real fast and see what this beauty could do.

LISTENING AND ADJUSTMENTS

After loading the modified cabinets with my favorite woofers and adding high frequency horns, drivers, and crossovers, it was clear that this rig had great potential. One of the first adjustments I made was to add a strut across the mouth of the bass horn. The large, unsupported area of plywood on the 5 foot sides resonated and rattled at certain frequencies causing some bass muddiness.

Since the horn mouth was essentially unchanged from the original Altec design except for halving the distance from side to side, I wondered why Altec or JBL, for that matter, did not address the matter of cabinet resonance caused by these large unsupported panels. Earlier RCA bass bins from the 1940s had horizontal and vertical struts across the mouth to eliminate the resonances that naturally results from large unsupported panels. Two more struts added internally further cut cabinet resonances.

Originally, the split 210 cabinet was intended to be a fully horn loaded bass enclosure just like JBL's 4550. While changing woofers, I left the center section of the three part back off. The effect of this "accidental" rear port was to increase the range of bass response. In addition, there seemed to be no sacrifice in the upper bass clarity with the reflex port in the rear of the cabinet as there was with a front reflex port. I found that I enjoyed the noticeably lower bottom end with the accidental port and decided to stick with a reflex port contrary to my original plan to have a full horn load.

I cut different-sized center board sections according to whether I would be using a Jensen, Altec, JBL, or EV woofer. The calculated effective interior volume of these modified bass horns was found to be 12



Right—"Double" modified 210 configuration with Altec 329A HF horn plus a 288 driver

cubic feet. At this volume, there is supposed to be no advantage in using a reflex port. However, after a good deal of experimentation, I found that a rear port of approximately 64 square inches seemed slightly preferable to a full horn loading in my listening room.

Now that the enclosure was about right, I tried two bass cabinets per side in both the upright position and then one stacked upon another in the horizontal position. Though not particularly practical for my narrow listening room, the horizontally placed double cabinets per side certainly sounded great. The two vertically placed cabinets per side with a nice 329A high frequency horn resting on top looked as cool as they sounded.

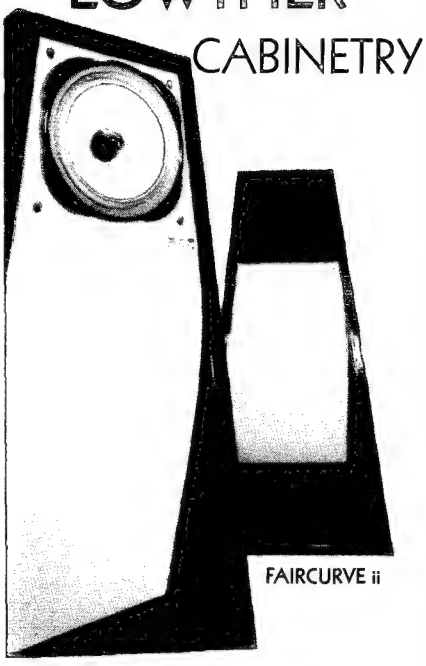
Cool as they looked to me, the females of the family opined that a single enclosure per side sounded every bit as good and had a nice, slim, minimalist look that was quite appealing. You judge for yourself from the photos.

SP readers wishing to share their experiences can write to me at 18435 5th Ave. N., Minneapolis, MN 55447. By the way, I might still have access to some 210 cabinets if anyone is interested...



Right—Single 15" modified 210 with early wood 808 horn/802 driver

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When it...finally...arrived...*SP #14* was a blast! Three *New York* power amps and an *Italian* phono stage with full details of how, when and why—which in a world overrun with micro poweramps masquerading as preamps takes big time courage—*Bravo Diego!*

I put my ass on the line with the heavily phono biased *TubePreamp CookBook* so I get very interested in seeing what others come up with in this trickiest of audio areas. Any half decent tube poweramp can sound acceptably musical, and line amps in this age of digital cut more than boost—but phono preamps have to handle very dynamic yet incredibly low signal levels—hit them with a wild equalization curve and all the while (hopefully) maintaining a *very* tight gain/phase relationship between the channels—so as not to corrupt a stereo picture hard won from a diamond to vinyl *mechanical* interface!

Before Diego's opus, a few passive EQ phono stages/preamps appeared in the literature; some balanced, most s/e:

- the legendary *Loesch* in SP#3,
- JC's *Siren Song* in SP#3 + #4
- Joe Curcio's *Daniel* in AA circa '85
- Erno Borbely's hybrid in GA 2/97
- My balanced *RTP's* in the TPCB
- My s/e *FVP* in the TPCB 2nd edition.

Now my intention is not to offend in discussing these designs, but to help make these units *even* better. And I've included my latest s/e effort so you can see where I'm coming from.

VITAL points in phono stages:

1 No loop feedback! No contest—the sonic advantages of dumping all time dispersive NFB and going *realtime* doesn't have to be preached to too many SP readers!

2 Use high gm tubes at high currents! Arthur Loesch runs those freaky 417A UHF tubes as RIAA inputs, with 6922's to follow—a man with soul! And why use such tubes? Consider this from Prof M. O. Hawksford *(HFN&RR 8/84):*

"...just as the stylus is required to resolve distances compared to the wave length of green light, so the (phono) amplifier is required to resolve charge levels in the order of an electron"

This is a MC cartridge hunting for the *extreme* low level ambience that makes great live recordings shift time and space so wonderfully—and a WE417A with its 25mA/V (or a 2SK147V with 40mA/V) will have *W-A-Y* more chance of perceiving and acting upon this lone little electron than a 12AX7 with one twentieth the gm. They're also much quieter, and at typically ten times the running current the associated impedances are much lower—which all helps the music roll on through.

3 Accurate RIAA! The three time constants in the original RIAA spec create four areas in the audio spectrum: under 50Hz, 50Hz to 500Hz, 500 to 2122Hz, and 2122Hz on up. Now normally a 1dB shift is not easy to hear, but such an error in one of these bands can make a whole system become light and bright (or dark and mysterious) because it moves at least two whole *octaves* of music bandwidth around!

Although not a cure-all, split time constant EQ is the way to go (unless you are a devotee of the KISS principle chasing *minimal* stage count) but the key advantage has not been emphasized by our authors: split EQ may or may not sound better—but it is *infinitely* easier to trim to exact RIAA conformance than any "all in one" topology. And trim it you *must* if you want to get real RIAA accuracy!

Your wiring capacitances will always be different to the designers unit, and unless you luck onto some 0.2% C's and R's of *exactly* the specified value, you won't be in the ballpark—even assuming the published values were right in the first place!

As detailed in the *TPCB:*

a) Acquire RIAA caps as close as possible to the spec'ed values. I use *WIMA* FKP2 polyprop and foil. Buy lots...

b) Match these caps channel to channel to better than 0.1%. N.B. Diego's *Audio Note* paper & oils may sound wonderful, but they don't come in the tolerances needed here—so you may need *quite a few* to find those *matched* pairs...

c) Input a square wave via a precise reverse RIAA network and then tweak the relevant *resistors* to get the best possible square wave out. I use 10 turn trimmers to start, and replace them with fixed R's once it's AOK.

Surprisingly, few designers suggest precise caps, and none say to match them *super tight* channel to channel. But Diego splits the network the way I found sounds best: with the 3180 + 318μS first and the 75 μS last...

4 Add the missing Time Constant! The 75μS networks in all these designs (except mine) fall at 6 dB/oct *forever...* OK, this may be the RIAA spec but if you think of the record cutting process—can they really boost at 6dB/Oct. from 2122Hz on up *forever*?

Back in the 70's we called some cutting equipment service departments and found they do roll off this boost with a chicane at around 50kHz (3.18μS)—so as to keep cutter head warranty claims to a minimum or whatever. And when this is done (in reverse) in a preamp, it flattens out that 75μS drop to hell and restores much of the air and naturalness that's on the master tape.

This is the purpose of R3 on the *FVP5* map, and it's pretty easy to try yourself:

a) Find the cap used for the 75μS roll off (i.e. 820 or 1000 pF in Diego's)

b) Calculate what R you will need to get 3.18μS in conjunction with this cap (= 3K87 or 3K18 in Diego's) using t = RC.

c) Fit it in *series* with the cap—and tweak for sonic satisfaction and *exact* upper octave ch annel to channel balance. N.B.: It's phase accuracy across all four bands that gives you that *real life* image the bottom feeders say don't exist!

5 Starwire Everything! I always *star wire* my modular stages to just one point each for B+ and gnd, and further *starwire* each of these modules to the power supply reference points—all with low impedance 3mm silver foil.

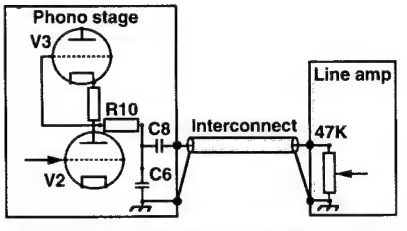
6 No redundant stages! This generally means high gain per stage. Most of the listed units need two stages in the phono for MM and three for MC—but the *FVP5* does MC with two and the *RTP3/5* does MC with just one!

And Joe & Diego, please...*NO* cathode followers, nowhere! I call them *Miss Piggy* as they sound just horrible, yet with some innovative thinking it's off to market for her...

For example; Diego's 75µS network is driven from the second tube, and followed by a CF. Yet he says this CF has to be very lightly loaded or it sounds *tired,* which is a very good description of the *Miss Piggy* sound. But if she can't perform, why use her at all? As the subsequent v/control is 50K, her only purpose is to isolate the 75µS network from the outside world—and that's a small job for a very big girl...

If the phono stage is in the same box as the line amp, this problem's minimal anyway and *Miss Piggy's* redundant.

But if they are separate, and if you're prepared to always use the same I/C between the boxes (perhaps a superb silver foil/teflon construction from the *SCCB?*) why not turn this bug into a benefit by using the high quality capacitance of the I/C as part of the 75µS?

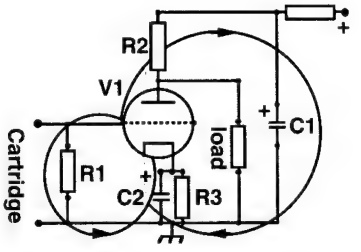


The *"Give Miss Piggy a Miss"* mod

Miss P is again redundant and should perhaps look to a career in the movies!

7 Circuit before components! Diego identifies the places where you need to spend money, and where it doesn't matter so much—but I say focus on these vital points and *first* get the circuit right to ensure you keep *all* the dynamics and information—*then* find the sonic flavor you like by playing with components to your heart's content.

8 No Electrolytic Caps in the signal path! No SP reader would ever e/cap one stage to the next, but do realize this also means no e/cap cathode bypasses and no e/cap B+ rail bypasses? I'm sure there are some real scientific terms for the "input" and "output loops"



Input and Output Loops

that exist in every stage, but these are good enough for a country boy to make his point with someone else's amp...so let's look at Diego's input stage:

Here the input loop contains C2, and the output loop contains C1 plus C2! Look, I know everybody uses these things—but does that make it right?

Every time I pull a cathode e/cap, things get cleaner, more dynamic and transparent, and when I also do the B+ rail correctly—magic occurs!

9 Use Shunt Regs! I agree that series regulators are a waste of time and do more harm than good, but a full house, fast and *current sourced* shunt reg will change your views on B+ bypassing and regulation—forever!

In my opinion the two most important articles ever to appear in SP rocketed right over most people's heads—but they contain vital info for all music lovers, so dig out SP#4 and #6 and read the John Camille articles. Their 211 amp is amazing but that's not the point—get into their shunt reg revelations. And if you don't get a growing feeling of excitement, then read them again and again until you do—and then study the *SuperReg* chapter in the *TPCB* for even more info.

We've been using shunt regs for 20 years and B & C's discoveries exactly parallel ours. The circuits are conceptually similar—so build up one of the designs (and one is enough even for stereo), pull all your B+ ecap bypasses, starwire the shunter into your box with *low* z wiring—and be prepared to be blissed. I'll spare you the superlatives!

The *FVP5*

Up until 1980 I was making *Audio Research* style preamps, but they soon became a dead end, with huge work needed to bring minor improvements.



The plug & play *SuperReg*

Luckily, lateral thinking mode kicked in and I tried what was essentially a *Tek/HP* 'scope gain block (balanced cascoded 6922's, no feedback) for phono and line stages. A complete shot in the dark, it was sonically wonderful and became our first (limited) production *Realtime Preamp (RTP).*

This concept is still the best I know and has evolved into the current *RTP3/5's.* This eighteen year long development path is fully documented in the *TPCB*, with (now) all the schematics.

But no matter how perfect a design you come up with *(has he got an ego or what?),* there are always &^$#@! minimalists hanging around waving their *"Bucky sez: Do more with less!"* placards and shouting their downbeat riff: *"KISS! KISS! KISS!"* But one day back in '85 or so, one of them actually put some $$ on the table and said:

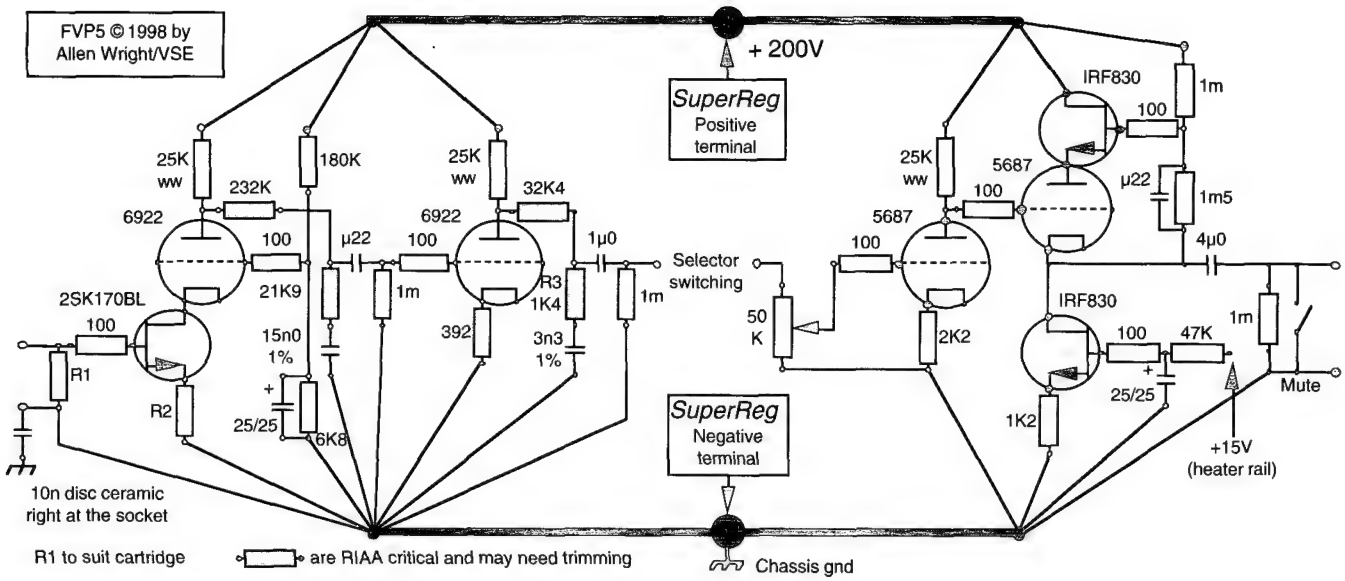
"I want a single ended Realtime..."

Cool idea, it sounded as dynamic as a *RTP*—just less refined and missing the super bass tonality. Forgotten for years, the concept was resurrected recently. Using the *SuperReg* and a few other tricks it finally became a serious device that—in hard wired form—was the first preamp I've ever heard that bettered my own—but on a PCB—*RTP3!*

Sure, there were a few false starts with SRPP line stages—not obviously ugly like poor *Miss Piggy* but they gross you out over time—and rest assured, a hard wired *RTP3/5* is another story...

Phono Stage. Enough back patting—I can already hear most of you muttering: *"Yukko—FETs".* But hear me out—I've built it all tube and this is simpler, cheaper and sounds even (slightly) better. The FET allows a *consistent* low noise figure that handles all but those *nanovolt* output MC's, and without the blurring (and horrific cost) that I find comes with step-up transformers. And used in this way (but only this way) as the bottom half of a cascode, this FET is *completely sonically invisible!*

Please, try it *before* you sneer, OK?



The 2SK147 is now out of production and almost impossible to get—but the readily available 2SK170 and '369 seem pin and chip identical. The only change is the TO92 package which limits dissipation to 400mW—but they're cheaper and the '170 is even quieter!

Schematic Details—Phono: A cascode 1st stage brings several advantages:

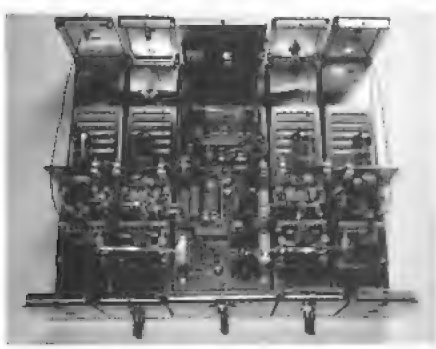
1- R2 can range from 150Ω down to 15Ω, which adjusts the phono gain from 40 to 60dB—with no side effects.

2- The high output Z means tube selection and/or aging doesn't affect the 1st part of the RIAA network—and with both the 3180 and 318μS points there you don't want too many changes…

3- It is inherently quiet, linear and very fast—which is why *Tek* & *HP* used it.

The stuff on the 1st grid ensures the FET operates at it's best point—it will work with the grid grounded (via the stopper!) but not at all gain settings.

This stage feeds through the RIAA into the second tube, a common cathode (CC) stage with (an unbypassed) cathode R—a topology that should *never* be called an *anode follower* because that's something *very* different: a tube "op-amp" with –1 gain from 100% NFB.



The prototype modular "kit" *FVP5*

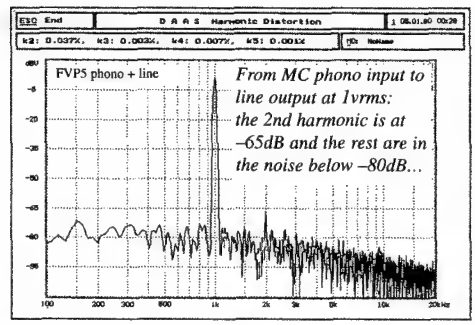
The cathode degeneration makes this stage more linear and again helps to keep things stable long term with differing tubes and the effects of aging.

It feeds into the 75μS network—where the trick 3.18μS time constant is formed by R3. Now if you can't figure anything like 75μS from these values—add in the 50K pot and the Rp of the tube as they're very much part of this network. The RIAA values given are those from the prototype "kit" *FVP5* (as pictured) and should be close—but tweek you must if you want it to *really* focus…

The Line Amp runs a hi gm low μ triode for a stage gain of 15dB—the lowest I could get while still having lots of current to keep it fast and clean. And even then it's more than digital needs. A 12AU7 works fine and octalists could try a 6SN7. First tube is a CC amp and then a very special output stage we call the *Super Linear Cathode Follower*. .

I guess with all my dissing of *Miss P* I'll have to explain the SLCF a little: It is the only cable driving stage we have found that's (almost) transparent—and came about after some serious study of *Valley & Wallman* back in '84.

They say a CF is helped by a current source in it's tail—sure, but it's not enough—so we added an *active* bootstrap to force the CF to also operate under constant *voltage* conditions, which is how they're supposed to like to work—and miracles of miracles—*Miss P* blossomed into *Jessica Rabbit* and I fell deeply and seriously in love!



MOSFETs, which are fine in (but *only* in) "secondary" signal paths make this stage tighter than if it were all tube—and this SLCF topology sonically *kills* the SRPP, the μF and *everything* else we have tried that has any muscle…

Enough *FVP5's* have been built to ensure the bugs are flushed, so you can build it with every confidence of having a real stunner. And it is—because it's fast, detailed and ultra dynamic, yet it *really* honours the music…

I still prefer a hardwired *RTP3/5* if only for its inherent ease of *absolute polarity* switching—but this *FVP5* has been in my system for six months now and it still impresses me, and my visitors.

Whatever…let's not forget why we do all this fooling around—and as the way cool Steven R sez:

Enjoy the music, dudes…

An InDHSET amplifier (In-Directly-Heated-Single-Ended-Triode)

by Vernon Taylor, Lyon, France

One step closer...

This little project may help or encourage those with just an overall knowledge of how valve amplifiers work (like me!), to design and build their very own design. So, those of you with real design skills, please excuse any mistakes that I have made—and in my defense I should add that my creation works very nicely.

I imagine my DIY audio resume is similar to many: first modifying by upgrading components (Linn, Naim, Wharfedale), then trying to build something from an electronics mag that didn't work (Graham Nalty's *ETI* pre-amp. I was too ambitious and tried to star-ground everything), then building something else that did (*Elektor* valve pre-amp—this time I didn't try to make my own PCBs), and then successfully building things from circuit diagrams (Jean Hiraga's 8W *Monstre*—no caps except the reservoirs). I think this sort of learn-as-you-go path is a necessary and fun way of getting where you want to go.

Output stage

So back to my new amp. It actually started as a lash-up of a direct-coupled 2A3 that appeared in *Sound Practices*. It didn't work (the 6A3 plate started to glow brightly); and despite the simplicity of the circuit diagram, I couldn't figure out why. I'll have to read up on Loftin-White and build something more traditional.

The importance of this first step is that I had actually started an SE project and so I had to finish. I decided to put the 6A3s aside and opened Jean Hiraga's "Initiation aux Amplis a Tubes" (1) for inspiration. I remembered reading something about an R120, and that it was an easy triode to build around as it's an indirectly heated triode.

That word 'indirectly' put me off a bit, but Hiraga says that the R120 has a much clearer sound than the 2A3 and that despite being indirectly heated, it keeps the DHT qualities of its more popular relatives. I should also mention that I found the tube at only 100FF ($16) which helped considerably in the final selection! (Note: my source apparently only had the two, and I've never seen them advertised or in catalogues elsewhere. There were only two companies that made them, Philips and Radiotechnique, so be warned.)

So the next major design choice was the output transformer. The R120 has characteristics that are very close to the 2A3/6A3 which means that the output transformer could be recycled for a future project using these tubes or even a 300B that I'm still hoping to find in an army surplus for a buck-apiece. I wanted a pair that I wouldn't be tempted to change in the future and that were cheap.

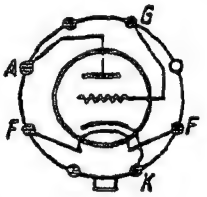
I considered Magnequest, Audio Note, Sowter, SJS, and a few others, but finally plumped for Partridge because of its legendary reputation, classic status, good reviews in *L'Audiophile* and *Sound Practices*, and of course the price. I got 'em for 89 Pounds apiece plus VAT ($130) when the Pound was just under 8FF, which I consider very reasonable for the quality and double-C-core construction.

The reference is TK 7441. This is exactly the same transformer as the highly sought after TK 4519 and cased TH4663/2 (TK is a reference for transformers delivered nude, and TH for those delivered cased). TK 4519 is a reference reserved for Lectron/La Maison de L'Audiophile. Partridge has a catalogue and now sell to the public in small quantities, e.g. two.

Power supply

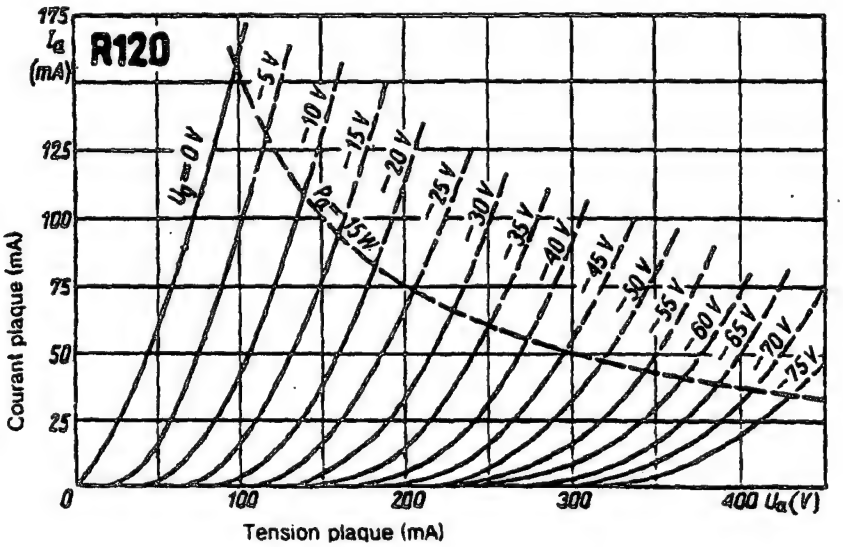
The power stage was completed by a power supply from my junk box, using a double-C mains transformer and a nice cased Partridge

TYPE R120
Indirectly-heated power triode



Class A Single-ended Operation

Plate Voltage	–250V
Grid Bias	–35V
Plate Resistance	840Ω
Amplification Factor	5.4
Cathode Resistor	600Ω
Plate Load	2,500Ω
Power Output	2.5W
Max. Plate Current	90 mA



6H choke that I had found for a fiver ($9). I had no 5V secondary which meant rectifying with some fast-switching silicon. I used a full-wave configuration and adjusted Cx to get my 300V. Making it smaller will reduce your B+ and vice-versa.

In fact, here's a little tip if you're more concerned with using the power transformer you've got, rather than the merits of rectifying with valves versus silicon or the smoothing and regulation advantages of choke-input versus Pi-filter. The final B+ can be adjusted from 0.45Vrms to 0.9Vrms using full-wave regulation and adjusting Cx, and from 0.7Vrms to 1.4Vrms using a bridge. Include also the voltage drops across valve rectifiers and the choke, and you can see that a very wide range of B+s can be squeezed out of your transformer. Note however, that for correct choke-input functioning, the minimum current drawn by the circuit should be:

$$\frac{2 * \text{sq.root of } 2 * \text{Vrms}}{6 * \pi\text{squared} * \text{fL}}$$

Vrms is the full secondary voltage before rectification

f is the mains frequency (Hz)

L is the choke value (H)

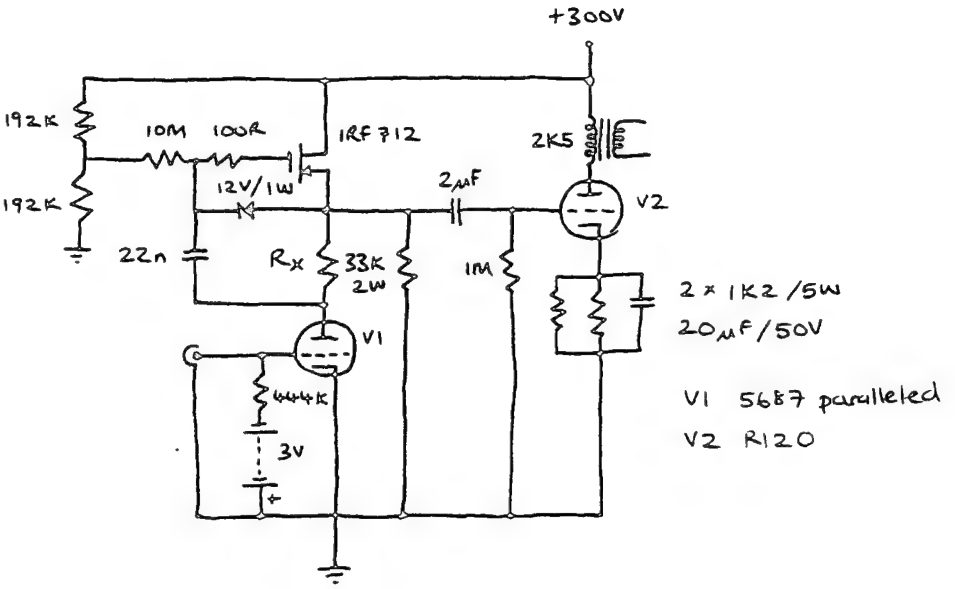
Your B+ will rise to 1.4Vrms if the current is too low. The above equation is for bridge rectification. Divide by 2 for full-wave.

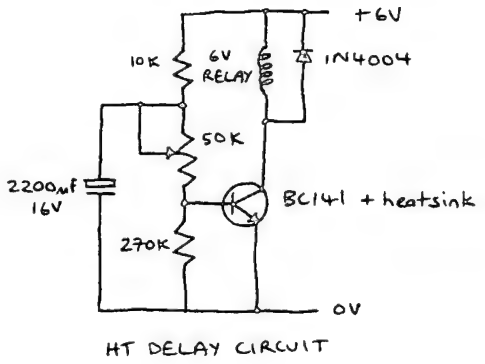
I fitted a mains filter and a snubber network across the choke to reduce spikes. (2)

The heater supply is DC, smoothed by some nice big caps and a resistor to complete the Pi filter and drop the voltage to 6.3V. I added a little delay circuit to let the valves warm-up before applying the HT.

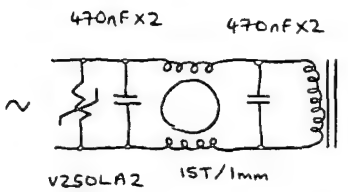
Driver stage

So all that was left was the driver stage. After the glowing experience mentioned, I decided to go for something simpler with a coupling cap (Infinicap had sent me a couple of free samples). I had found Alan Kimmel's Mu-stage (3) interesting, so that was thé reason for its selection, along with the fact that it needs a 300V B+, which is conveniently more or less what the power stage needs—actually 250V on the R120 plate, and –35V on the grid, so 285V in all plus the voltage drop across the output transformer primary. Practically perfect, huh?

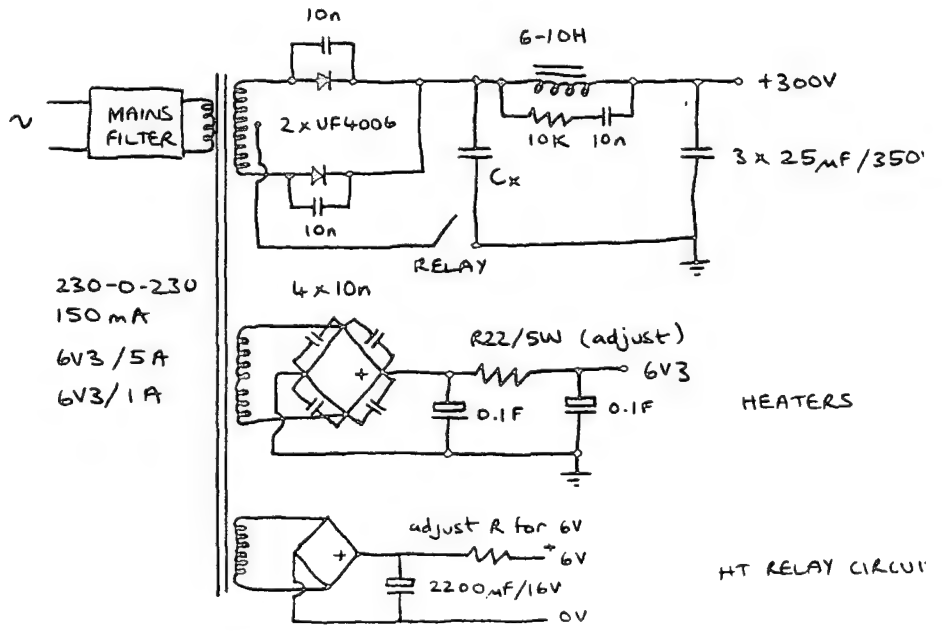




HT DELAY CIRCUIT



MAINS FILTER



HT RELAY CIRCUI

POWER SUPPLY

The driver valve choice was between those in my junk box: ECC8X, 6SL7, 6SN7 and 5687. I didn't fancy using the first—not enough street cred', I wanted to keep the 6SL7/6SN7 for a pre-amp project, so that left the 5687. Audio Note uses it to drive their 300Bs, and I read something good about it elsewhere, so why not I asked myself.

I chose Rx as per Alan Kimmel's article, and put in a battery bias because I liked the idea on a gut level, and also because it cut out the usual cathode bias resistor and electrolytic bypass.

Construction

I made a chassis out of MDF for the top plate and pine planks for the sides—not particularly because it's non-magnetic, but more because wood is easier to cut than metal. It also looks nicer too. The valve sockets were mounted on a copper sheet to act as a ground plane. I mounted half the components on RS tag board and the other half made the connections from the tagboard to the chassis-mounted components.

Single strand silver insulated with teflon tube was used for signal connections, and silver-plated polypropylene insulated multi-strand for the power wiring. Resistors were military surplus, all caps are polypropylene excepting the filament reservoirs, and the diodes fast-switching types. Absolute values are not critical. A lot of the values were chosen because that's what I had—so use what you've got. Rx in my case is 6k3, and Cx is 25uF.

It may also be worthwhile playing around with the bias and value of Rx. Kimmel recommends that no more than 10% of your B+ should appear across Rx so as not to limit too much the maximum output voltage swing. However, I have a lot more than that and things are fine, but the R120 doesn't need much driving. When I get around to it, I'll change Rx to 2k, which should satisfy Kimmel's condition.

Use a 2A3/6A3/6B4G if you can't find a couple of R120s. Remember though that these are DHTs and will need the bias resistor and decoupling cap in the heater circuit. They need around –45V meaning a resistor value of around 750Ω for self-bias. If you need more front-end amplification, use an ECC83 or 6SL7. This will increase the driver gain from around 20 to 70.

So what?

So, that's it. It worked first time, except that there was no bass. As I had built a stereo unit, I had wired up the two channels identically, forgetting about the speaker terminals. Changing the wires round on one of them revealed that the bass was not bad—in fact, rather good. It was better still on the 3k5 tap of the output transformer compared to the 2k3, but I reckon this will depend some on the speaker connected. An ohm or two difference in the speaker impedance is equivalent to the difference between the 2k3 and 3k5 taps.

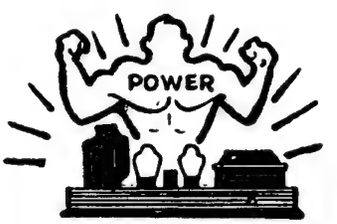
The amp seems to have taken longer to settle down than I remember for transistor designs, but I'm very pleased with the results and feel that I'm one step closer to where I want to go.

References

1. Hiraga, Jean, *Initiation aux Amplis a Tubes*, Eyrolles

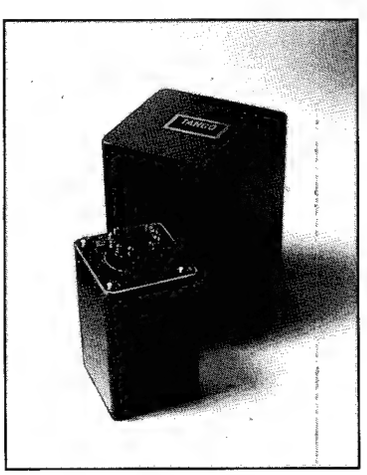
2. Jones, Morgan (1995), *Valve Amplifiers*, Newnes

3. Kimmel, Alan (1993), *The Mu Stage*, Glass Audio 2/93



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Casual Reactions



by Herb Reichert, Audio Note NYC

The Matrix of Culture

Anyone familiar with my *Casual Reactions* column will have noticed that I like to speculate about the relevance of leading edge audio engineering and that I am constantly seeking to place this research in a larger cultural context. I can't help it, because it is impossible to study the basics of electronics without realizing how primary the physical laws that govern electronic circuits are. Changing energy from one level or state to another is fundamental to all science and a principal technology in human culture since the dawn of man.

In a very short time, less than 10,000 years, humankind has dematerialized its own culture. The objects we now manufacture tell us less about our present cultural state, than the data we store on discs and reels. Who we are, where we think we come from, and what we aspire to be are buried in some form of stored data, somewhere.

The archaeologist of the future will not be brushing off stone tablets. He will be resoldering traces and listening for archaic signals through headphones. The anthropologist will be studying microfilm. Signal and data recovery will become the primary tools of the historian, anthropologist, and archaeologist.

The archaeologist of the 30th century will need to decipher forgotten languages buried in electromagnetic code. His lab and study will be filled with discs and reels and scopes and meters. Screens and loudspeakers will surround him. He will transduce and decode. Part of his task will be to restore and reinvent ancient playback machines.

Our attention is turning away from the sensational interplay of natural forces and man's role within these forces. Instead we simply accept our role as "caretakers" of the planet. Our new "job" is to collect information about our collective selves and our environment. Great collaborative efforts now organize this information so that it may be used to solve problems concerning our longer term survival. Our culture itself is now rapidly becoming information and theories of information.We have come to see problem solving as a process of data retrieval, sorting, and analysis.

Surprisingly, if we look broadly enough, we notice that the majority of this alluring information is stored on discs and reels, played back over and over and sent amplified through antennae to pulsate through space.

We create data, we store it, we transduce it, we study it and we give it power, transmitting it, globally and out into the stars. Alien anthropologists must see humans as doing only two things; moving heavy objects from place to place and transmitting data.

The contemporary human enterprise is evolving into a global ideas/technology generated matrix of coded electromagnetic waveforms. These vast interlocking waveforms are now, quite literally, the first living, vibrating, archaeological remnants. Like cultural DNA, this pulsating, encoded, electromagnetic plasma is becoming our species fingerprint. It is the ever-evolving, spherically-expanding, musical score of our civilization.

Remember, these are storage media we are discussing. The stone tablet and book were first but now, since the development of magnetic science, we have a rapidly evolving succession of cylinders, discs, reels and cassettes, each storing more information than the previous incarnation.

The big break with the past appeared when we began to store sounds where we can't hear them and sights where we can't see them.

History is Superimposed upon History

We speak, we tell stories, we sing songs, we do business, we conduct experiments and everything that we do is recorded and then transmitted via periodic electromagnetic energy into the vastness of the galaxies. Interestingly, this larger matrix predates civilization and is, itself, an electromagnetic record of the history of the universe.

Imagine vast layers of electromagnetic grid fields, pulsating, morphing and folding one upon another. Imagine these grids generating harmonics of themselves, picking up and dissipating energy, being pushed one way or another by electromagnetic, solar and celestial "winds." Imagine our own thoughts, movements and worldly interactions as organized disturbances in this electromagnetic medium. Imagine our narrow bandwidth human activity morphing harmonically into the wideband electromagnetic spectrum. Imagine the effects of playing music or acting drama, recording it and playing it back....over and over. Every solar eruption is super-imposed with *Citizen Kane* and Eric Dolphy. A symphony of ideas and dreams and aspirations is being written in electromagnetic code in our own remote corner of the ether.

The musical waveforms, the CDs and LPs we so innocently play with as hobbies in our living rooms, can easily be seen as very tiny "micro-models" for the whole picture. For the moment, the symphony, the raga or the song appear to be tangible glimpses of the big picture we are all seeking. The "where do we come from?","who are we?" and "where are we going?" questions are most likely already answered—they are out there "coded." Recovering stored musical information to be played back, over and over again, is nothing less than a sacred enterprise.

Audio Engineering

Lowly and often disparaged, audio engineering is potentially the most profound of the science disciplines. It can be seen as a distillation of all branches of science. Its primary purpose is to create machines that allow humanity to share in the examination of our most important scientific, religious, and philosophical data.

This is a grand enterprise. It is the beginning of man's first multi-disciplinary odyssey into real self-knowledge. The study of information storage and recovery, especially *analogue* storage and especially *musical* information, may be the core study that ultimately unites the now separate fields of science, art, and philosophy.

Audio engineering must be considered not as a subtext to hard science or the bastard child of electronic engineering. It must not be allowed to become a trivial branch of the entertainment industry. We must not too quickly forget that it is the armature of twentieth century scientific and cultural growth.

Audio engineering is the mother of all waveform and electromagnetic study. It is not only a core technology for cinema, radio, television, communications, computers and data processing, it is also related in substance to scientific studies in fields as far reaching as propulsion, atmosphere science, leading edge particle physics, quantum mechanics, and astronomy.

Transmission and content

I believe that it is reasonable to assume that all of nature's secrets, the answers to all our better questions, are already encoded and stored! More than likely, these concepts are stored in the larger and smaller interlocking electromagnetic energy matrixes that envelope us. Perhaps, quite literally, the answers are "blowing in the wind"—or broadcast from our radio?

Accepting this, it is obvious that nothing could be more shallow than discussing audio engineering in terms of detail, soundstage depth or bass slam. We must stop focusing our attention on the clarity of the transmission and begin to recognize and examine the patterns of the content.

Our audio equipment can be considered at least *adequate* if it directs our attention towards the content of these messages. When the music is playing we must be allowed to inquire about more than just *the sound.*

Unfortunately, almost none of our best audio equipment accomplishes even this simple feat. If audio equipment did indeed direct our attention towards the larger message, we would certainly not be wasting so much time discussing soundstage and bass definition. We would be considerably more busy decoding and analyzing the structure of what is on these discs and reels.

Typically, the 'hard science' school of audio design looks only at linear and steady-state data, hoping to recover a clean stream of amplitude and frequency modulations.

What tends to be forgotten is that the larger audience for *musically-encoded* data is receiving a confusing, severely edited and highly simplified version of the original musical event. It is almost as if another layer of "black ice" encoding has been added. The information has not only been magnified (amplified, with all the inevitable distortions that entails) but has gone through yet further, unnecessary stages of encoding.

Unfortunately, one cannot encode (or decode) information if they do not read and understand the language of the original. Presently, the communities of art, science, philosophy and religion could not be more ignorant of each other and this ignorance has contributed mightily to our inability to recognize the significant patterns in the data we experience.

In fact, each of these disciplines has developed a lexicon so singular as to be barely intelligible to the others. The lack of a shared lexicon or even a pan-disciplinary approach to study is surely the biggest roadblock to any understanding of the bigger ideas being entertained today.

Let us presume, just for the moment, that we can recover and play back some crystals of musical code in nearly their virgin, but slightly amplified form. (I not only believe that this is possible, but I believe that some of the no-feedback single-ended triode technology emerging today has been quite successful at this.) Would the music and art loving public at large truly be able to process this information? Would some basic "where do we come from?" questions get answered? I believe so!

Here is how it happens. At first you will hear some lone shouts and momentary exclamations, "I've got it!" But no one will really take notice. In fact, many of you have already experienced this. The process has begun.

The solitary voices of those few who have experienced this new 'virgin data' have, by now, joined into small choruses. Worldwide there are little pockets of people emerging from their listening rooms and studies - instead of their minds reflecting on right and wrong or their lips speaking of profit and loss, we see the drunk-trough, glazed over eyes effect of a new innocence. The data was right there all along, we just couldn't distinguish it.

The technology is in place. The data is already stored. We can now begin the new anthropology. Starting perhaps with Thomas Edison and "Mary Had a Little Lamb," we can start examining the code, looking for the primal melody. We can begin to look at our culture broadly, not through a magnifying glass but through a pair of loudspeakers.



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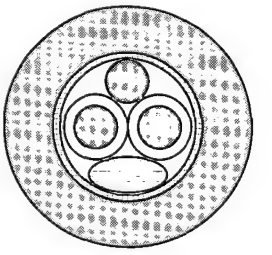
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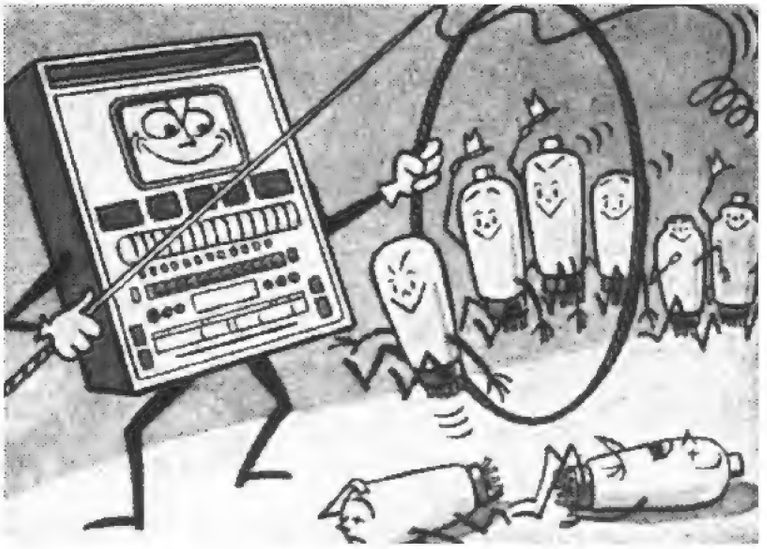
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Getting Hooked Up

Issue 16

KINKY triodes



by J.C.Verdier
Laboratoire J.C. Verdier



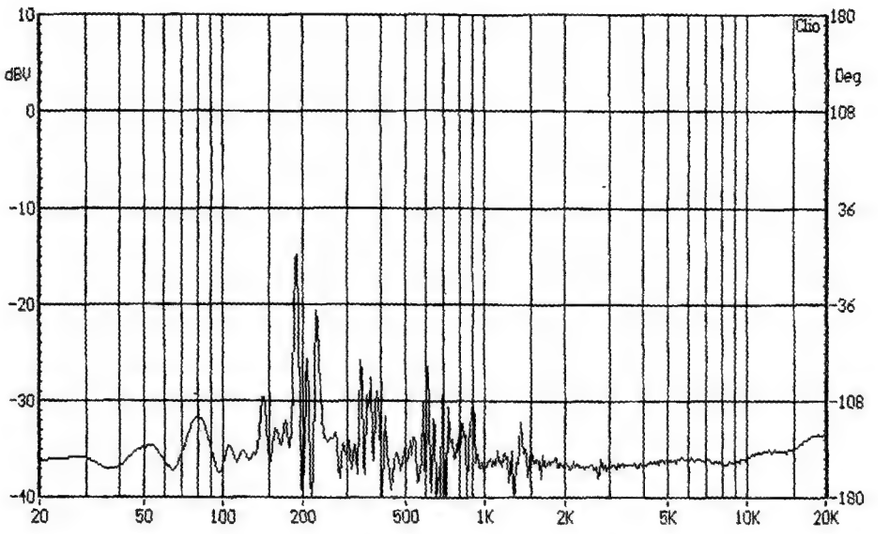
This photo shows a 300B without glass bulb whose plate has been cut with shears to examine its internal structure. We clearly see that a spire of the grid is greatly deformed and moreover the spraying of emitting coating on the filament is totally irregular and goes beyond the grid's structure down towards the base, making proper operation of the tube impossible.

The producer of tube amplifiers has a very difficult task to fulfill. It is an important affair because the satisfaction of the customer is in question. That satisfaction is most often based on a simple criterion explained as follows: "Some years ago, I bought an amplifier, it is good and works well" — or, unfortunately: "The amplifier I bought is not good because it always fails."

We all know that failure in an amplifier is practically always provoked by the power tubes and for two main reasons:

a) The tubes are used beyond their official characteristics of voltage, current and power.

b) The tubes are used properly but they show inferior characteristics due to defective manufacturing.



That 300B - high quality construction - but atypically the graphs show a preponderance in the resonance of the filaments and support wires located at about 200Hz while the grid's resonance is attenuated.

By artistically mixing points a) and b) we can easily produce some marvellous electronic fireworks.

The a) point can easily be improved, it is sufficient to take a safety margin in the value of B+ applied on the anode of the power tubes, without forgetting that for a main voltage of + 10% the B+ voltage will follow the same increase. Yes it is easy now, but only 10 years ago a customer was very shocked if we presented a push-pull amplifier with 6BQ5 with less power than 17 Watts or another one with 6CA7 unable to give 50 Watts well packed as in a parade like in the RCA handbooks.

Yes the customers understand that now, too much available power has to be paid for swiftly, even very swiftly, by serious failures, and today the push-pull with 6BQ5 gives 8 to 10 Watts and their elder brother with 6CA7 stays around 25 Watts. There is only one problem, that kind of circuit is considered old-fashioned in light of triode single ended amplifiers with direct heating. Among them, the amplifiers with the 300B tube are the most numerous and when I approach that famous and magic number —300B— I enter the heart of my subject.

The 300B triodes, hard to find some years ago, are now the subject of diverse offerings from various sources. The manufacturing qualities, the ability of the producers, and the often very high prices are each subjects for investigation. I have to answer them very carefully for myself at any moment to always keep the quality/price ratio of my product attractive. To get the answers, I put in place a special checking process dedicated to the 300B. Four different chapters will follow, they must take place at least on lots of 10 pieces to be significant.

APPEARANCE TEST

That begins by the measurement of the weight of the tube—a simple scale for letters will be enough. That measurement is very indicative of the global quality of manufacturing, because it indicates a possible tendency to quibble on the materialis quality used, even if a material such as glass or steel should be a very low cost compared with the price of a finished tube. That fact is extremely indicative of a certain frame of mind of the manufacturer.

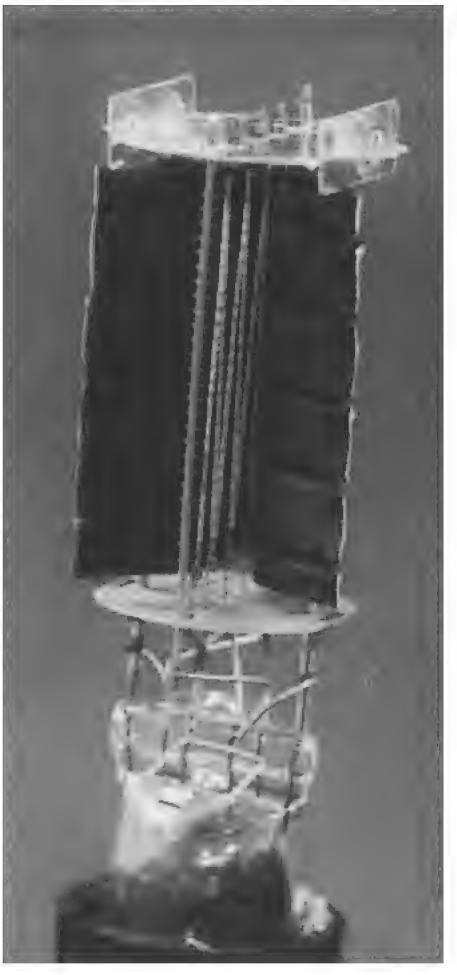
After that come esthetic appreciations about the fitting inside the glass bulb. The perpendicularity of the bars relative to the mica parts reveals a careful assembly. On the contrary, if we have a repetitive and visible failing of perpendicularity on several tubes, we have to look forward to poor performances as regards characteristic dispersion and linearity.

Examination of the micas is also important. Split or nicked micas are the result of a less careful assembly process. In that case, some mica parts bounce around inside the glass bulb. We must look carefully at the glass where the dumet wire leads pass through the glass stem. If the tube has received big shocks during transport, the glass can chip, leaving tiny bits of broken glass to jump around inside the glass bulb. That last incident is unfortunately frequent and sometimes it is a real heartbreak to see cleanly manufactured tubes damaged in transit as a result of inadequate packaging.

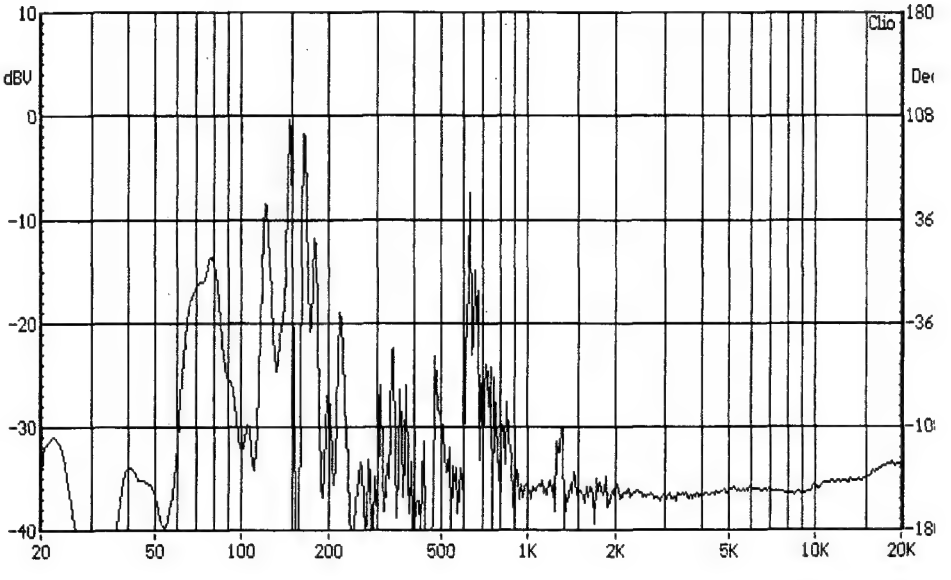
The problem of inadequate packaging is quite impossible to solve because that work – really fundamental – is often left to an incompetent and changing staff impossible to suitably train.

The previous observations can be made on the whole tubes. To pursue the examination, we must break the glass bulb, of course that will be made only after all the measurements described below are finished!

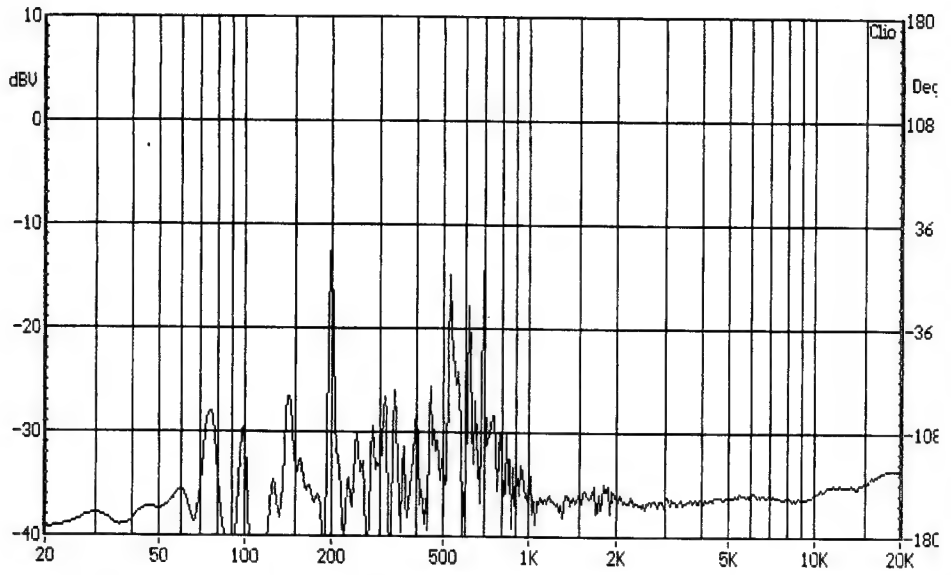
When the glass bulb is broken, we have to open the plate with very little cutting pliers – in order to avoid deforming anything – and observe the grid and the filament. The grid must not show any distortion.



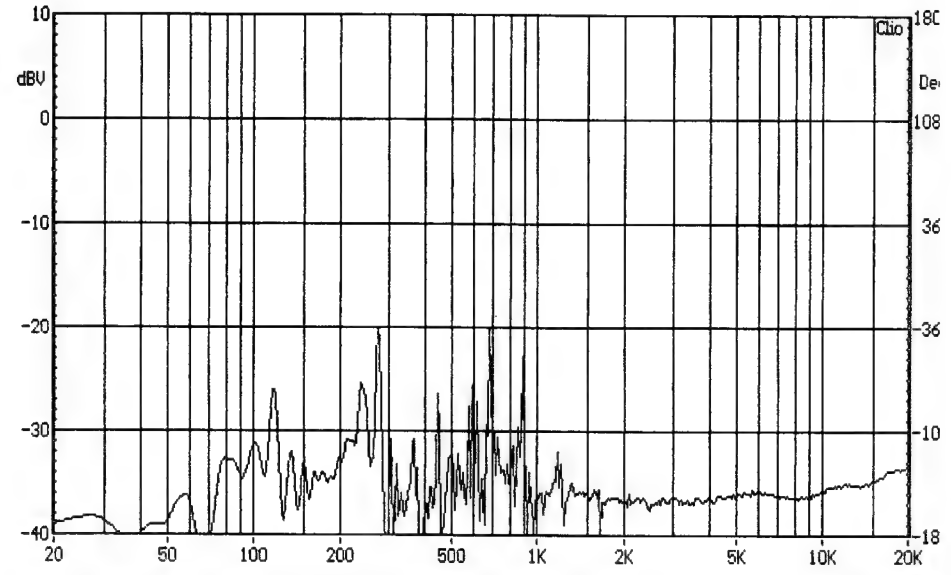
This photo shows a 300B with a regularly spaced grid and evenly applied filament coating. A little part of the emitting coating has flaked off the filament wire and is missing, but this is the only defect noticeable in this tube.



Very mediocre result (the worst result we obtained). However, the tube placed at work does not show its weakness of composition during listening tests.



Very honorably good and typical result, it indicates precisely that we are facing a high quality production unit.



The best result obtained on those first measurements. Good blood cannot lie.



Installation prepared for the microphonics measurement. The loudspeaker is placed as near as possible to the tube. The components are locked in place so that the measurement conditions are repeatable.

Sometimes we see that a grid spire has been hit unfortunately and that the two next grid spires are shorted together leaving a large free space for electron flow.

Another common failure is the spraying of the electron emissive coating. It is applied too high on the filaments, leaving a surface of emissive cathode more or less above the grid, which is then unable to control the electron's flow. That defect combined with the first one gives a tube where the grid is not able to control completely and continues to let flow a little current even for negative grid voltages as we will see during the electrical test.

Failure of the visual tests as described above is a bad sign and the forecast of a rapid deterioration before the final cut.

MEASUREMENT OF CONSTANTS:
Amplification Factor, Plate Resistance, Transconductance

Computers help the producers to automate complete measurements of the tubes. Before that it was unthinkable to make complete measurements because of the very substantial time investment they could take.

A good technician could draw a network of power triode characteristics in about one hour (if he worked as quickly as possible) with a conventional instrument such as our METRIX U61. Probably the same operator could have taken some liberties interpreting results—how can he reject a tube as he made the measurements of it in one hour? A capable technician would probably beg and implore us to avoid making him do stupid work. So, this was the reason why it was not possible to measure all the tubes systematically. Like I described above, times have changed.

Now, with an ordinary PC and a system such as Audiomatica's CLIO, one can measure and record all the characteristics of tubes in a way which is nearly a pleasure. Matching is made easy by superimposition of the characteristics and it is possible to appreciate the linearity given by the tube when it is in place on the amplifier. We clearly see on the drawings the colossal differences between a very good tube, an acceptable tube or a completely bent tube. And more, we can expand the base of the curve by the variation of abscissa scale and remove any doubt.

Those who imagine that 300Bs having the characteristics shown on the graphs are rarities make a mistake, I meet some of them during any measurement campaign. That failure is provoked by the imperfections described in the preceding paragraph about the step of the grid and the spraying of the filament.

In fact that failure mode provokes a flatness of the signal for sine waves which wears the grid towards the very negative areas, near cut-off. That gives an important increase of "pair" harmonics (the ones which are pleasant for everybody), we have to ask a question on this matter: is that failure provoked deliberately by the manufacturer of the tubes to give a warmer sound to his product? [Nah, I think they just messed up. -ed.]

MICROPHONIA

All the 300B tubes have a tendency to be microphonic. We used to tap on the glass bulb to check this parameter, but I think a measurement is better.

The setup for the measurement I devised includes the following: a good size power amplifier (1 X 70W Monobloc in class A); a loudspeaker able to receive the power (JM LAB Profil 3); a test amplifier (2300B modified) to power the tube we have to test.

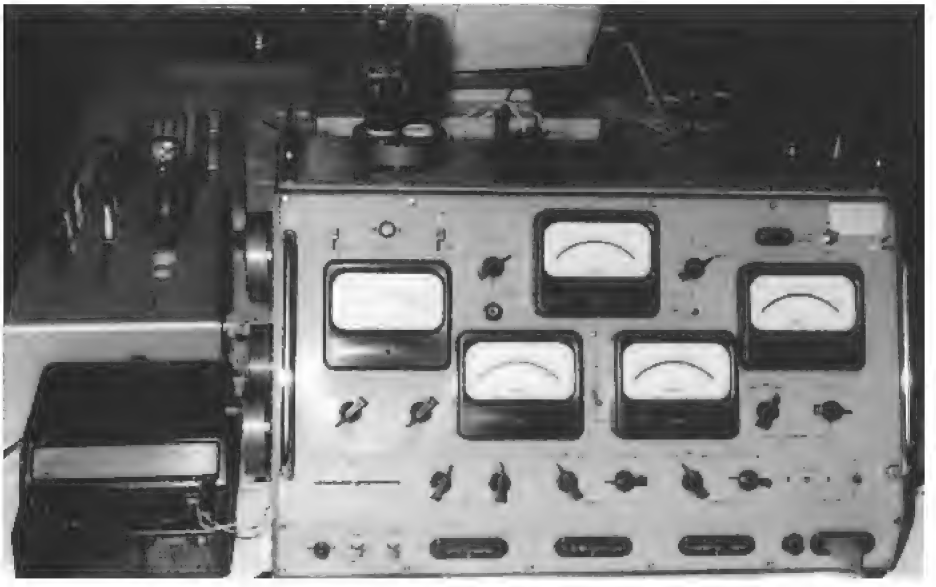
The CLIO is programmed to come out and analyze 5 consecutive salvos of MLS sound. That signal is applied to the 70W amplifier which modulates the JM LAB loudspeaker itself placed as near as possible to the 300B tube under measurement.

The amplifier carrying the 300B is prepared for the measurement, the grid of the 300B is wired to the ground to prevent signals coming from the preamplifier stage from disturbing the measurement. The output of the amplifier is connected to the input of the CLIO which makes a FFT analysis of the MLS salvos of sound and shows the average measurement on the PC screen.

During the measurement, the operator has to wear hearing protection. That noisy test is very indicative of the rigidity of the tube's internal mechanical fitting. We can see important differences between productions with microphonia sensitivities varying up to 20dB for one model to another.

Examination of the graphs also shows that there are 2 main resonances. One is due to the filament movements and is generally situated about 150-200 Hz. The other has about the same magnitude but a higher frequency (about 500-700 Hz) which corresponds to the grid vibration.

It is clear—listening tests show it—that a less microphonic power tube is better when we listen to it, for a simple reason: if electrodes are mechanically unsteady and move and vibrate according to the violent sounds provoked by our measurement,



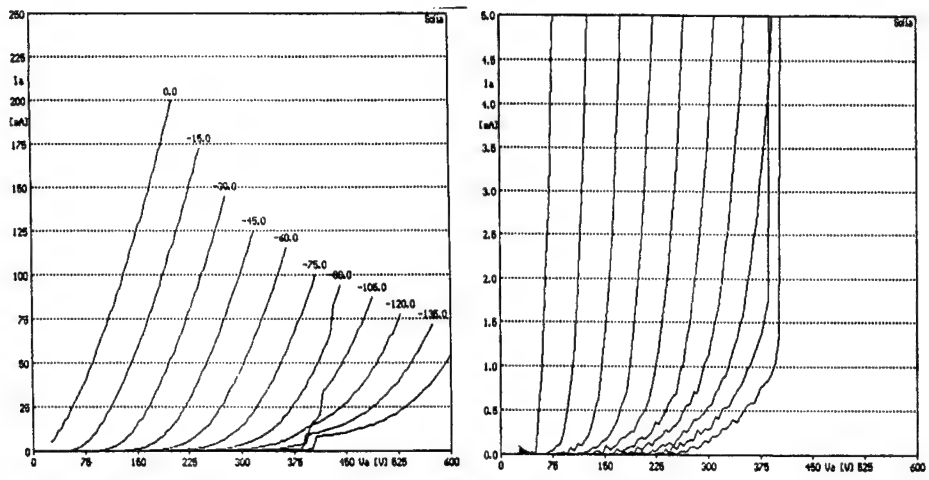
Test bench for vacuum measurement



M. Hiraga looking at the spotlight galvanometer to read the grid current



Printout of plate characteristics



With this tube, the confusion reaches height. But we have to be honest about the cause—we dropped this tube through clumsiness and all the internal structure is twisted due to the fall. Absolutely suited only for listening to hard-rock music!

N° of sample	Ionic current (nA)	Vacuum factor	Note
1	50	0.5 x 10-6	New
2	32	0.32x 10-6	New
3	55	0.55x 10-6	New
4	135	1.35x 10-6	Twisted grid
5	7	0.07x 10-6	Used
6	30	0.30x 10-6	Used
7	75	0.75x 10-6	Very old
8	65	0.65x 10-6	Very old
9	275	2.75x 10-6	Unsteady vacuum

Measurement chart of the ionic current

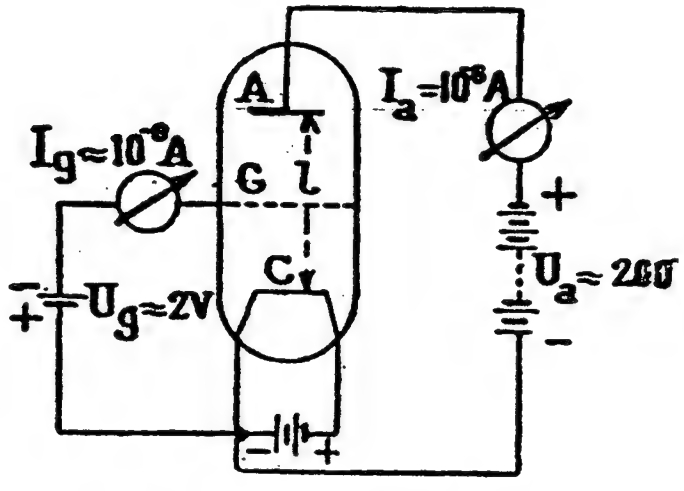


Fig. 2. — Mesure du vide.

Original schematic from Barkhausen book for the vacuum measurement

they also move when they are at work for a musical reproduction, perhaps according to the variation of the internal electric fields. However, this explanation is a hypothesis, it remains to be demonstrated scientifically.

MLS NOISE

The CLIO System provides a noise called MLS. When we listen to that noise, it seems to be a random white noise. In fact there is nothing random about it. It consists of a blend of sinusoidal signals of differing frequencies, carefully arranged and repetitive. The repetitive nature of the noise signal allows the analysis system to operate very swiftly due to recognition of the amplitude and the phase of the signals it processes.

COMPARATIVE VACUUM TESTS

A good vacuum is essential for electronic tubes. A poor vacuum reveals defective manufacturing. It can mainly indicate that there are leakages—certainly tiny ones—but they will shorten the lifetime of the tube. It also indicates that the manufacturing process is not completely perfect and has not been properly finished.

A bad vacuum does not allow stable work conditions, especially since it promotes ionization of internal areas when high voltage is present. Perhaps it is useful to explain the process of pumping modern tubes to clearly understand the whole problem. The method I describe here is a digest of a very complex reality which can be different from one manufacturer to another and also according to the model of tube.

After being completely assembled (but without its base) the exhaust pipe of the tube is connected to a double pump system fitted in series consisting of a primary pump producing a rough vacuum and a molecular pump producing a strong enough vacuum to allow heating voltage and high voltage without formation of electrical sparks between the electrodes.

During the pumping, the tube is surrounded by a coil excited by a high frequency current to heat the electrodes by induction. Simultaneously, the electrodes become red hot due to the high frequency heating, the oxides sprayed on the filament are reduced to form the final cathode emitting electrons, and the getter (a kind of little cup containing magnesium) is evaporated by the heat.

Thanks to this process, the last gas inside the electrodes is drained off and captured

by the magnesium of the getter which contains them when settling on the internal part of the glass bulb by condensation to form a reflecting area like a mirror. After all those operations, the tube is cooled and installed on its base, and it will undergo the final formatting operations of the cathode and all the tests dedicated to show its good working or its rejection.

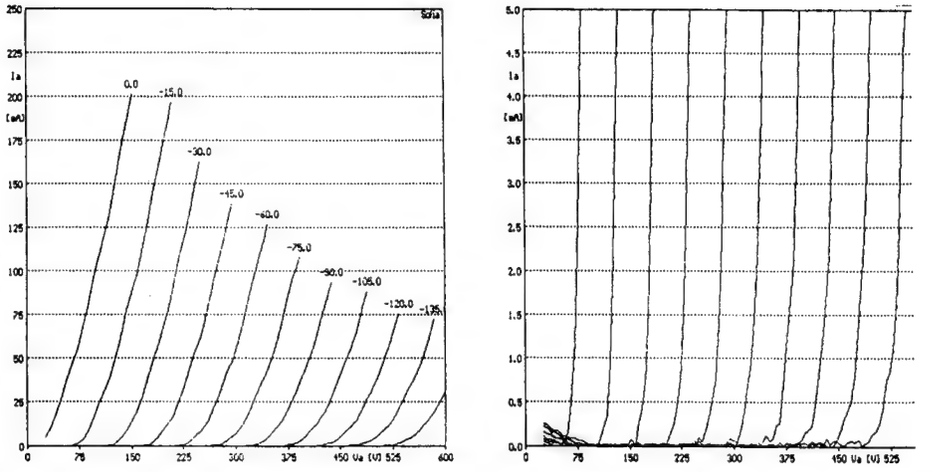
Now, I present all my apologies to the specialists of tube production who read the previous prose which doesn't do justice to the incredible complexity and the astonishing know-how in action to lead the operations I described with so much simplicity.

For example, two or three things I know or believe to know: The production of the 'mixture' coated on the filament to form the future cathode consists of about 300 different chemical components which must be perfectly pure. The vacuum is considered as good for a value of 10^{-6} mm/Hg. To obtain that figure, it is necessary to eliminate a proportion of 1,000,000,000 gas molecules for 1 remaining. Yet the remaining molecules number an amazing 28,000,000,000 by cubic centimeter of "good vacuum."

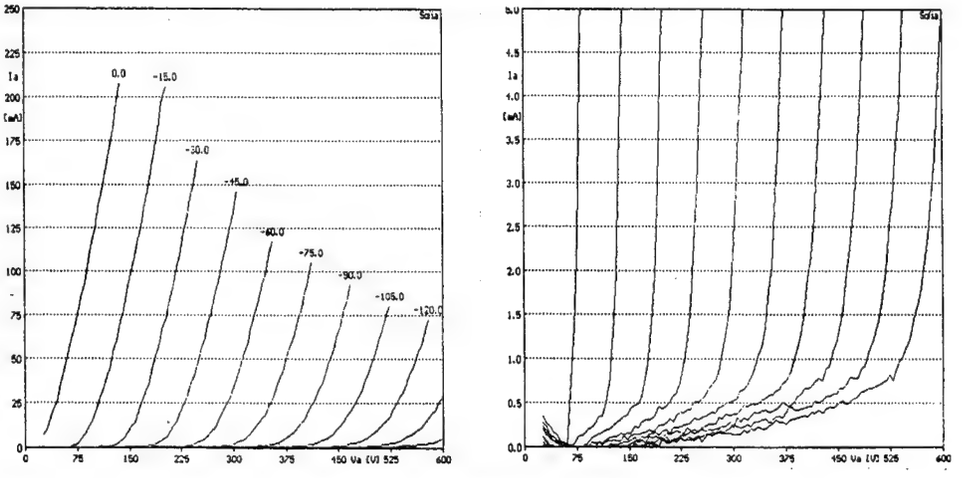
The comparative measurement I propose seeks to underline the presence of those undesirable gas molecules by bombing them with the electronic current of the tube in function as shown on the diagram.

We see that the plate becomes positive by a voltage coming from an adjustable regulated power supply while the grid receives a negative voltage of - 50V. The voltage of the plate is adjusted for each measurement so that the plate current is always 100mA. A micro ampere meter is inserted in the grid circuit and indicates the concerned measurement by the following mechanism: The grid being negative pushes away all the electrons moving between cathode and anode, but it attracts and captures the positive ions produced by the shocks resulting of the impact between flow of electrons and undesirable gas molecules remaining in the glass bulb.

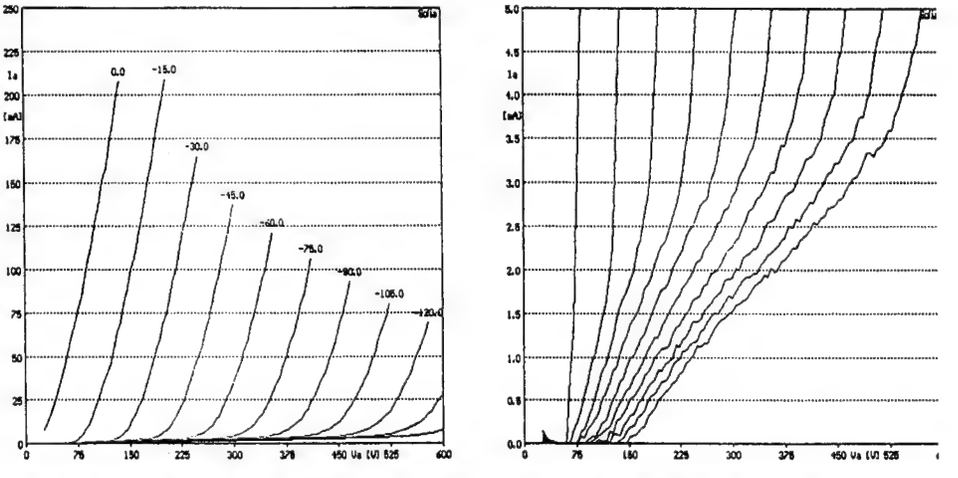
The ionic current indicated by the micro Ampere meter is compared with the whole electronic current and shows a number we call vacuum factor. Theoretically it is possible to calculate the real vacuum (in mm of Hg) from this vacuum factor and to consider the dimension of the different electrodes, but that precision does not concern us here, as we are comparing tubes of the same type with



Characteristic curves of a quite perfect 300B. Left graph shows the complete curve, right graph shows the dilated curve (limited at Ip = 5mA). We clearly see that the plate current is completely controlled. The irregularities of this curve are due to the internal noise of the measurement system and do not reflect on tube quality.



Here is a tube which is perfectly usable, but whose grid assembly has a defect. It is practically impossible to cut the anodic current while the plate voltage is > 200V.



The same failure mode as above, but here it would not be possible to use the tube. This failure can be easily detected with a classic tube-tester. The current we obtain is higher than the norm and we could believe that the cathodic emission of the tube is of the best quality. Unfortunately, this is a bad interpretation. The actual cause is a serious problem in the coil geometry of the grid.

practically the same characteristics.

During these measurements, I made interesting and amazing observations. Very used tubes generally have a better vacuum factor than the new ones. The ionic current of a new tube, abnormally high at first, is stabilized after some minutes of work at a correct value. I found only one tube with a bad vacuum, unsteady and higher than the average. No doubt that the vacuum is the most delicate parameter to obtain but it is also the most watched during production.

CONCLUSION

The reader will have noticed that all the measurements published in this article are only given for example, no trademark is mentioned. The reason is that some of the results were very bad. I could not do it without the agreement of the firms concerned, because I risk big reprisals. I would like to publish in a future issue of *Sound Practices* a truly comparative article. To do that, it would be necessary to receive samples from the producers or distributors with the authorization to publish the measurement results. I think that it will be difficult to put in place, but one is always allowed to hope!

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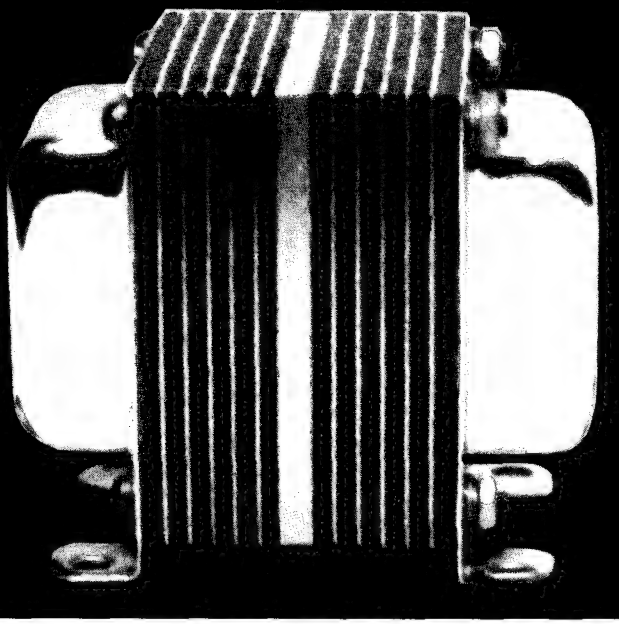
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THE EMT927 & EMT930 TURNTABLES

by Heiner Jakobi

The 927 (R-80)

Introduced in 1951, the EMT 927 was a massive turntable with an aluminum chassis, measuring 67.5 x 52 x 21.5 cm with a weight of 80 pounds. The platter has a diameter of 44 cm and sits in an amazing precision ball bearing. The bearing shaft is 16.6 cm long and has a diameter of 2 cm! The motor itself is massive. It looks like an industrial motor, 13.5 cm in diameter and 20 cm long! It is a 3 phase synchronous type with phase shifter.

A precision manufactured 3-step pulley is mounted on the motor axis and a precision idler transfers the power from the motor to the inside rim of the platter. The idler wheel can be shifted to the 78, 45, and 33 1/3 rpm positions for speed change. The platter itself is extremely heavy and the mass is distributed mainly along the outer rim. A special motor brake allows for fine adjustment of the speed. The massive power supply can be switched for 110/120/220 V inputs.

EMT turntables come with either 50 or 60 hz motors. However, Japanese and Korean EMT fans use separate oscillator power supplies or rely on the braking system (which allows about +/–10% adjustment). Some give the pulley to a precision metal worker to machine it 1mm down in diameter.

The early version of the EMT 927 (remember that in the studios the 927 was named R-80!) had no phono EQ built in and no PS to feed one. An EQ had to be ordered as a separate unit, called the EMT V-133, or V-83 in studios. This was a mono unit. In its early version it used metal tubes and then later the venerable ECC-40, an early kind of 12AU7 but much better and very dear these days!

There was a "measuring version" of the R-80, which has a glass-rubber mat instead of the standard acrylic platter mat. This mat is considered the best, and I agree fully that it is the best choice for the 927. It was later remanufactured in Japan but with a quality standard not quite up to the original. The "measuring version" was called the EMT 927D. The EMT 927A had an optical instrument that showed you the exact position of the cartridge on the record grooves. This was a very useful tool in the studios.

The next generation of the 927 was equipped with an on-board power supply to power the new EMT 139 phono equaliz-



The EMT 927

er. For a short time, Pabst motors were tried, but they were not quiet enough so they went back to the old design built by SMB Metalltechnik nearby, the supplier for most of the metal work for EMT.

Mr. Schundenmeier, the former technical head at EMT died in 1997. I last spoke with him in 1996 and he told me of plans to bring the 927 back into production, but sadly this did not happen.

With the introduction of stereo, the new versions of the 927 were labeled 927st with the 139st EQ. The first solid state EQ was named the 155, with a stereo version 155st.

For a long time, the tonearms used on the 927 turntables were made by Ortofon, as well as the cartridges. The early arms were mono, of course. They can be changed to stereo with some inventiveness (and an old 10" Ortofon or EMT studio arm to use for parts). The early 12" Ortofon-made arm was called EMT RF-297, the stereo version RMA-297. Both arms are straight 12" arms and high mass designs, meant for use with Ortofon-EMT, Ortofon, and Neumann studio cartridges. There is no provision for anti-skating since it is not required for tracking forces above 2.2 grams.

These tonearms were reintroduced some years ago, as the demand from Japan was very high. The later EMT-built tonearm, the 997, was a completely different design—lighter, with different bearings, and not S–shaped but curved. It is a matter of taste which of the above-discussed arms are better, since all of them are excellent.

EMT also built a special version of the 927 turntable, the EMT 927S. It is very rare and very sought-after since it had a provision to use a second 12" tonearm on the back. Some people use, very sensibly, the SME-3012A (original) arm as the second tonearm, allowing the use of not only the studio cartridges but ordinary cartridges as well.

It is also possible to buy empty EMT headshells to fit other cartridges, but the advantage in using the 3012A speaks for itself. The 3012A is THE tonearm for the SPU-Gold or the SPU-Meister (Meistro). If no 3012A is available, then I do not recommend the 3012 versions with the plastic bearings. Go for the later versions with the metal bearings. The late model doesn't match the 3012A in sonic qualities, but it is still a very good choice.

The 927 in all its incarnations is one of the most sought-after turntables in the world.



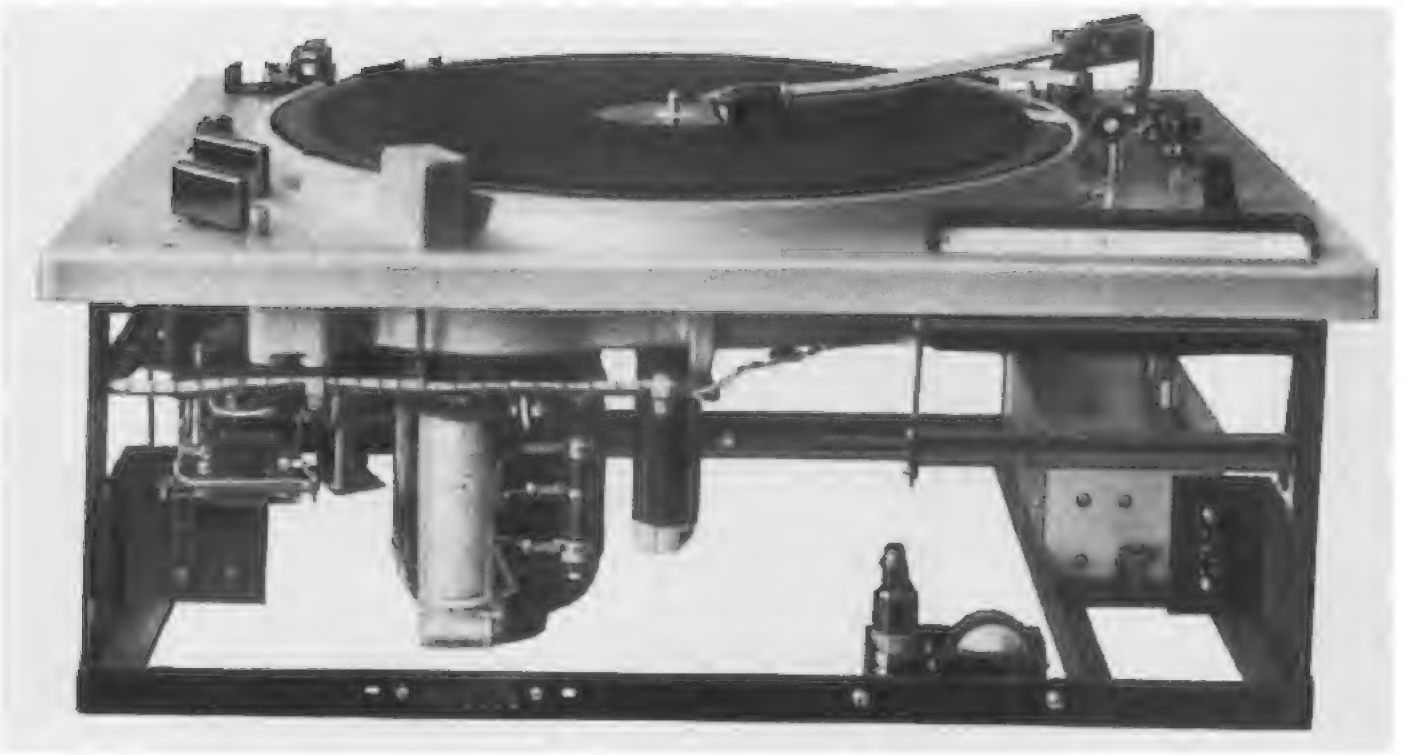
Authority, authenticity combined with stability—that's how I can describe this Rolls Royce (Mercedes) of all turntables.

The EMT 930

Introduced in 1956, the EMT 930 was not intended to replace the 927, rather it was built to meet the requirement of studios that did not need to work with the big platter of the 927. It had a smaller but very clever chassis made out of bakelite with a 30 cm platter and 10" tonearm. It was built in much larger quantities and is easier to find but nearly as expensive as its bigger brother. It weighs 45 pounds and measures 50 cm x 39cm x 17.5cm. The motor and bearing are a bit smaller than those of the 927, but of similar quality. The 930 motor



EMT 930: Exploded View



still looks like something out of an industrial vacuum cleaner rather than a turntable. The bakelite chassis is extremely dead, but here I must warn anyone who ever ships a 930 to take the bearing and platter assembly completely off of the turntable. Otherwise, the three arms of the bakelite chassis might break off! If this happens, the only answer is super glue, so this is something to be avoided!

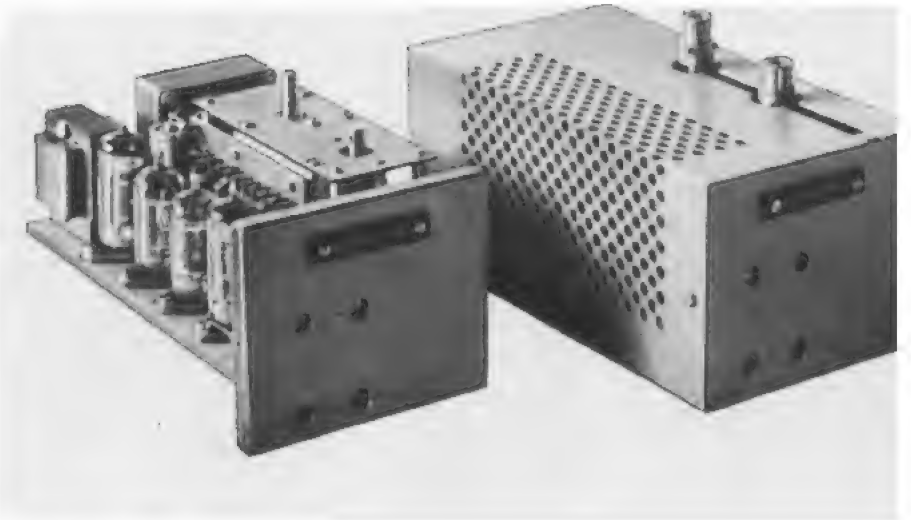
The 930 has one of the best bearings I have ever come across and you can still get spares from EMT! The 930 was equipped with the same phono equalizers as the 927, and here it is time to speak about their quality. They are not all on par with the turntables.

The 139s are very sought after and fetch high prices, but sonically they do not compete with good modern tube designs. The EMT-133/V-83 is the best, if the curve is modified to RIAA. A pair of mono 139As come second, then the 139st. Forget the 155s! The 153s and the Swiss Eymann are better, but still not worth the money. If you find a 927 or 930 with the tube EQ, then sell the EQ. If you find one with a 155 or 153, use the chassis to build your own phono preamp inside. I often used a simple Neumann design with modern parts and first-class Neumann MC transformers (which outperform all transformers I know of) or our own Phonogen design. With the EMT preamps, you cannot even get close to how these tables perform.

The early Ortofon 10" arm was the RF-229 (mono, can be modified to stereo) and the RMA-229 (stereo). The late EMT-made arm is called EMT-929 and is still available. The stereo version of the EMT-930 is the 930st. Most 930s were eventually fitted with a stereo tonearm.

Be careful with the power supplies! If you have the early model for the 139eq, then you can plug in the 155 as well, but if you want to use the 153, then you will have to change the pin layout! Same for the Eymann equalizer, which is pretty rare. But again, these equalizers do not give you the full pleasure you can have with these wonderful turntables.

The 930 sounds very similar to the 927, with a little less authority and a bit more speed. The difference is a matter of taste. Of course, the 927 is more sought-after and worth every penny of its higher price. It is the question of whether you prefer to drive a top Mercedes or a top BMW! A Garrard 301 is a good Austin Minicooper.



EMT139 Mono EQ for the 927 Turntable

The EMT Cartridges and Tonearms

As mentioned before, the first EMT cartridges were all built by Ortofon. In German, they are called "Tondosen", i.e. "heads," because they are built into a headshell ready to be plugged into the arm. There is no need for alignment—the correct overhang and angle is given automatically! We have the OF-series and the T-series. The O-series are all mono heads.

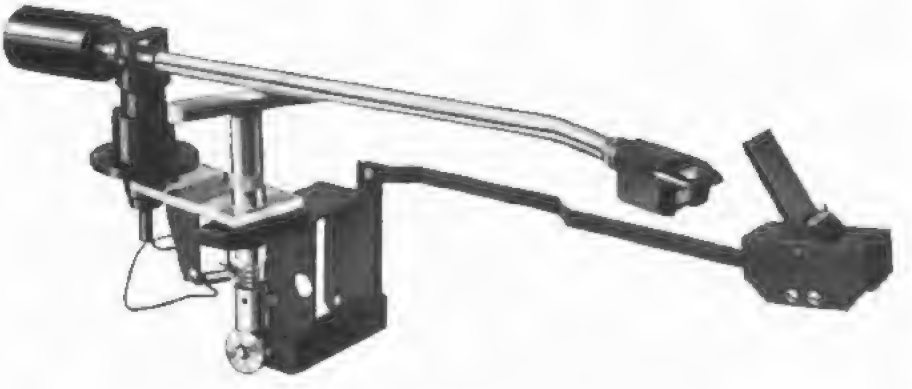
When EMT started to manufacture their own cartridges, they kept the same names as when they were built by Ortofon. However, they changed from bakelite to a special magnesium alloy for the headshell material. For 78s, it is recommended to use the sapphire tip because it sounds much better. It doesn't last as long as the diamond tip, but it is much cheaper.

There are several other very famous cartridges built by EMT listed in the table to right. Also turntables: The Thorens TD-125 was built for Thorens by EMT. The EMT-928 is a modified TD-125, but these are not at all comparable with the 927 and 930 units. It would be better to go for a Garrard 301/401 with a SME 3012A or FR-64s.

TYPE	TIP	RECORDS	TRACKING
OF-25	sapphire 25	monomicrogroove	5 gr
OFD-25	diamond 25	monomicrogroove	5 gr
OFS-65	sapphire 65	78s	9 gr
OFD-65	diamond 65	78s	9 gr
TSD-12	diamond 12	stereo	2-3 gr
TSD-15	diamond 15	stereo	2-3 gr
TMD-25	diamond 25	monomicrogroove	2-3 gr
TND-65	diamond 65	78s	2-3 gr

Other Cartridges manufactured by EMT

v.d.Hul MC-1a/b	No longer available
Roksan Shiraz	EMT TSD-15 in Roksan body
Tubafon TU-2	Naked TSD-15
Tubafon TU-2S EMT	Special version of TU-2, the best available and one of the world's best cartridges for a good price
Thorens TMC-63	Head/armtube only for Thorens TP-16 mkIII
Thorens MCH-63	Head/armtube only for Thorens TP-16
Thorens MCH-1/2	90% of a TSD-15, but with a softer suspension for Thorens/EMT tonearm



The EMT-Ortofon arm for the EMT 927 shown with arm lift mechanism

Other tonearms that work well on the EMT-927:
SME-3012A, Stax UA-70N and 90N, FR-66s, Ortofon RMG-309
For the EMT-930:
Ortofon RMG-212, Stax UA-7N/cfN, FR-64s—but not the so-called FR-64 shown in SP# 5, page 18!! Please since this is an Audio Technica AT-1503, a very cheap arm, not a FR-64!! The AT-1503 may be OK for a Garrard, but the FR-64 is of a different class.

When purchasing a used arm, it is always wise to check the bearing quality. If the bearings are no good, then you will only get 20% of what is possible! The EMT tonearms will only allow the use of studio cartridges from EMT, Neumann, or Ortofon. However, you can use an empty head to install any cartridge.

If you wish to go for a different tonearm, then the Fidelity Research is the best choice for the 930. You will have to raise the bearing a bit (easily done), otherwise you can't adjust the height of the tonearm as well.

For the 927, go for the FR-66s, the EMT 3012A, or any 3012 with metal bearings. But remember...the old Ortofon arms are being reissued for Japan and sell for high prices there—and there is a good reason for this! The Ortofon heads are wonderful also— as are the EMTs!

Installation

There is an EMT shock absorber frame, the EMT-900, which was designed for the EMT 930.This heavy unit decouples the EMT from any acoustic feedback and resonates at about 7.5 hz. It was designed by Mr. Schundenmeier, and it is still available since an ex-employee of SMB-Metalltechnik started to manufacture them again. The author can offer them at a price of $1500, which is the price EMT charged for them back in the 80s! The 927 never had a shock absorber frame but it is available now for $2000. These frames completely isolate the turntables from vibrations and they are very heavy and built in a sophisticated way. If no isolation is needed, i.e. good floors and stands, then a good console (Studer made very good ones) or homemade console will do with no problems.

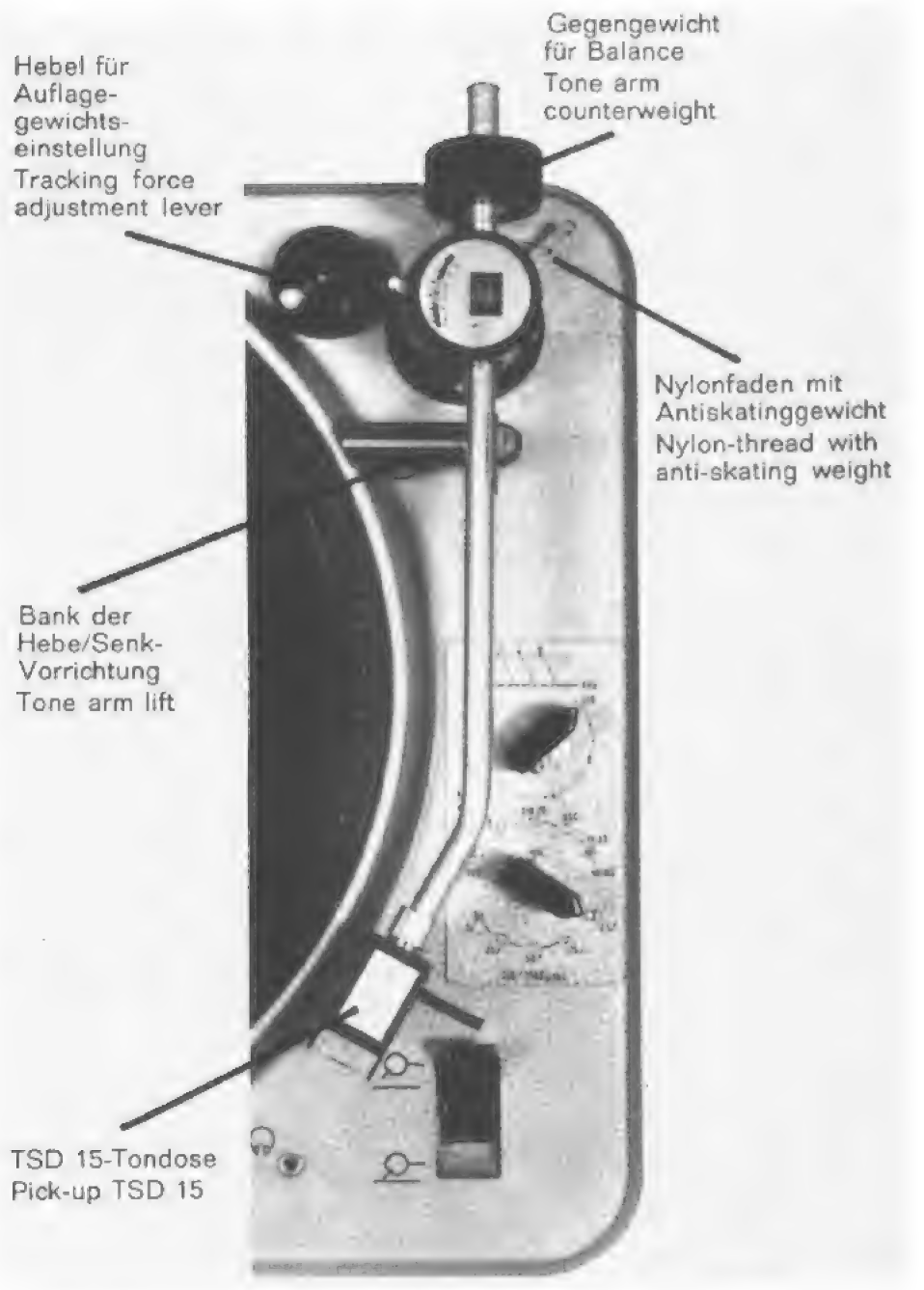
A homemade console should be constructed with marine grade plywood with a 25.4" x 20.5" cutout for the 927 and 18.5" x 15.35" for the 927. Make sure the 930 sits on the rubber pieces supplied. If they are missing, use round rubber with a diameter of about 7mm between the underside of the chassis and the console. A very useful support for a small custom-made console is the Seismic Sink by Townshend Audio. Never place the 927/930s on the metal frame. It must be sunk into a console or similar setup, or else it will not sound good!

Service of the EMT turntables

All EMT studio turntables are built to run 24 hours a day, 7 days a week, 365 days a year. EMTs service instructions are based on this kind of continuous use. For the normal user, it is necessary to oil the motor and idler bearings every year, and to change the oil and clean the main bearing every 5 years. EMT oil is still available. Of utmost importance is to align the motor, the idler, and the bearing so that they are all parallel in their axis. EMT sold special tools to make this easier, but they are not available anymore, but it is possible to do without them.

Modifications

I only recommend two modifications. First, I do not like the fine speed adjustment and I removed it from my 930, resulting in more subjective clarity and "speed"—same rpm, of course! Then, I do not like the original platter mat. This unit only serves two functions: to read accurate speed with the built-in stroboscope and to stop the record immediately with the platter brake for studio use. This is not usually necessary at home.



EMT 929 arm on 930 turntable fitted with a TSD15 tonehead

I had best results with an acrylic mat from Sumiko made with a sandwich construction. Both work extremely well and I am sure that some experimenting would bring desired results. I wish somebody would produce a teflon mat like the one on the Well Tempered Signature! If the tonearm sits too high due to removal of the stock mat, then just raise the main bearing. There is 1cm of adjustment available and no disadvantage in doing this. The same goes for the EMT 927 but there the "measuring" glass rubber mat is the best choice. I tried a pure glass mat once but this was terrible. A simple felt mat is not enough. This is not a Linn or whatever baby turntable.

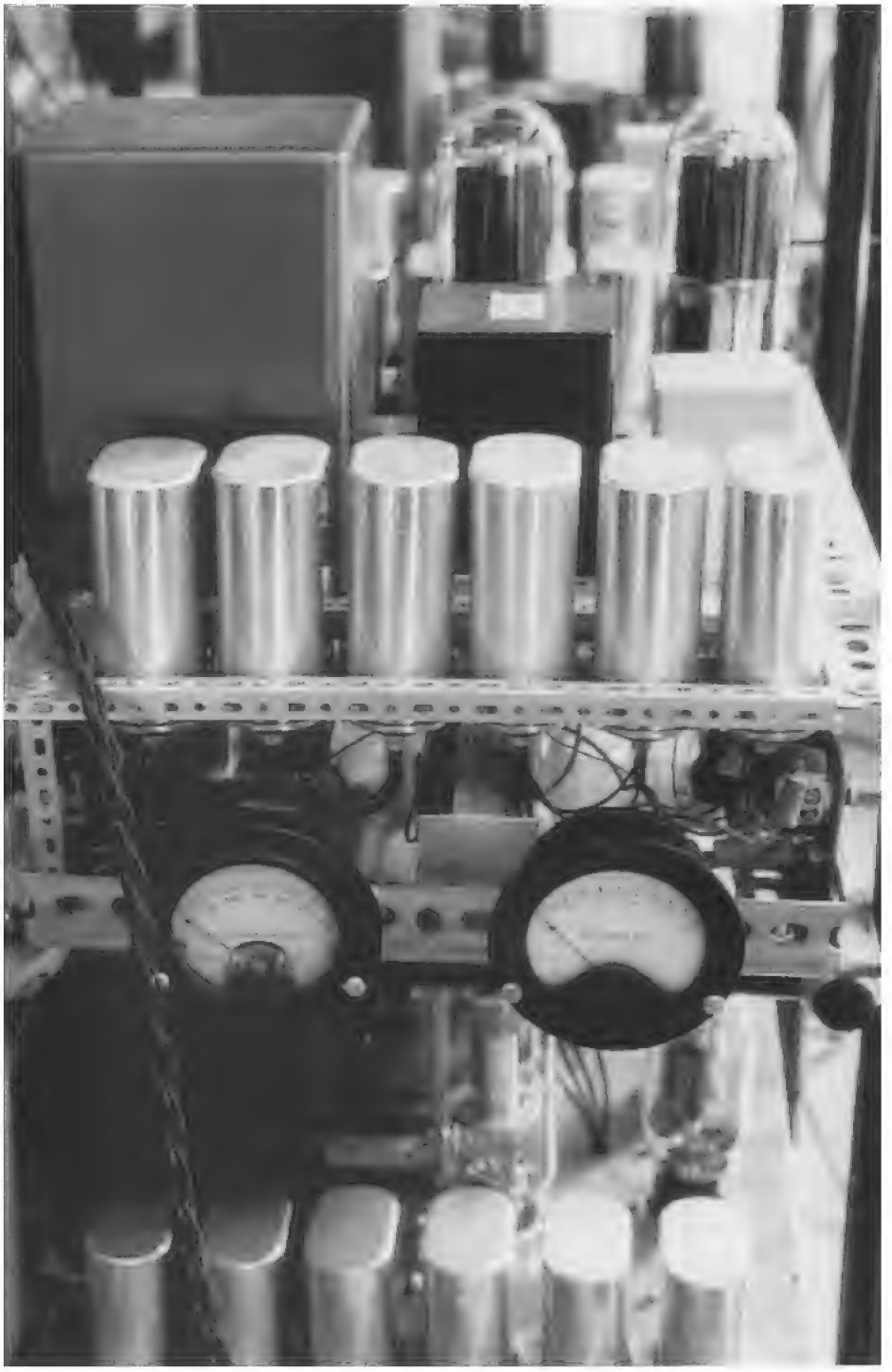
And, lastly, there are more modern designs built by EMT, but they are direct drive and I never heard one yet that satisfied me! I would prefer a nice modern heavy mass turntable. The good thing about EMT is that you do not lose money! The keep their value or climb up like old WE or McIntosh gear and they are built for a lifetime!

The author can be reached at the following address: H. Jakobi, Alte Schule, 55758 Sulzbach,GERMANY.



Homebrewer of the month

Thomas Mayer of Munich, Germany



I got into the tube arena in 1989 with some used EL34 push pull amps and an ARC SP9. This blew away the solid state stuff I had before (Threshold & the like). Then, around 1992, I got hooked on single ended with a commercial SE 300B from a small German manufacturer.

When I needed some replacement 300Bs I got no help from the manufacturer. This poor service brought me into the DIY scene. I studied ads of tube suppliers in British HiFi mags and finally ordered some 300Bs from Audio Note. I read about *Sound Practices* in their ad and ordered all issues they had (*SP*1-5) at that time.

This was around 1994. I remember how I was fascinated by all those circuits in this mag. I knew nothing about tubes back then, but I got really hooked. I bought some literature like the *RDH4* and started with small steps. First attempts where 6SN7 and 6SL7 SRPP stages for a DAC (I had fiddled around with digital for a while).

That didn't satisfy me for long and I quickly planned on a SE amp to replace the 300B monos. That led me to the 211 for something *serious*. The 211 was chosen as the output tube for a few simple reasons:

— I already had a commercial SE 300B amp.

— My 92dB speaker could use a bit more power.

— The 211 is easier to drive than an 845.

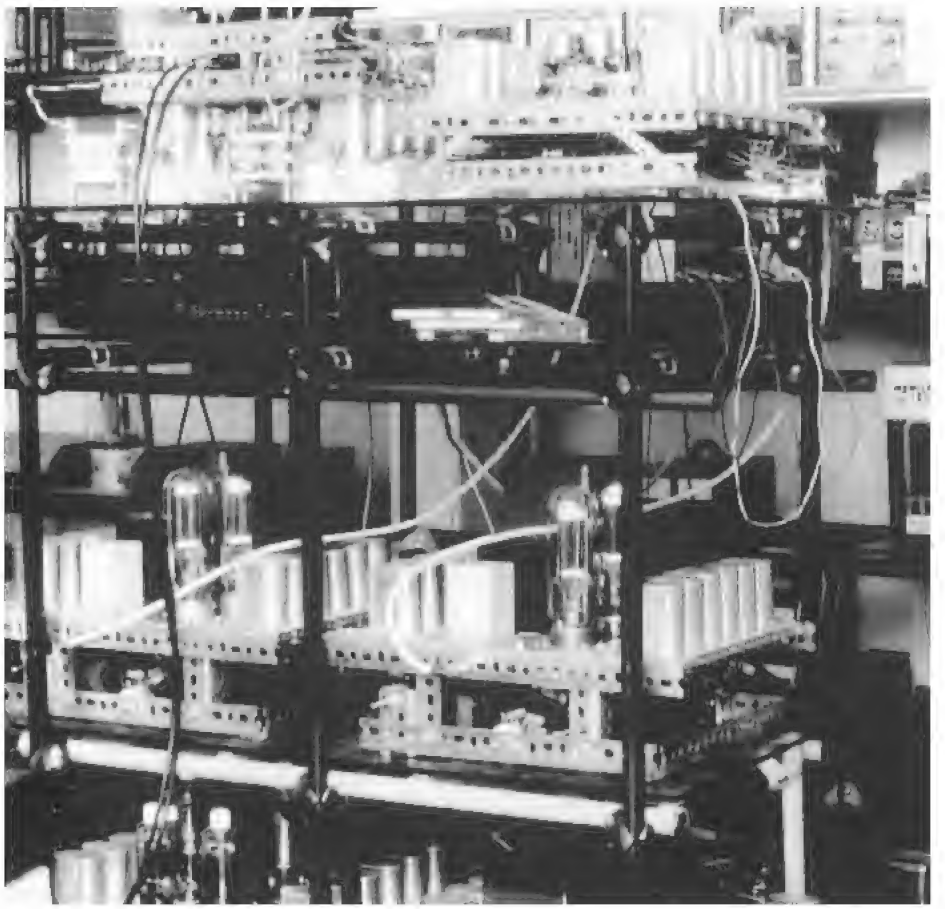
— NOS 211 are still available, while the 845 is difficult to get.

— It looks cool.

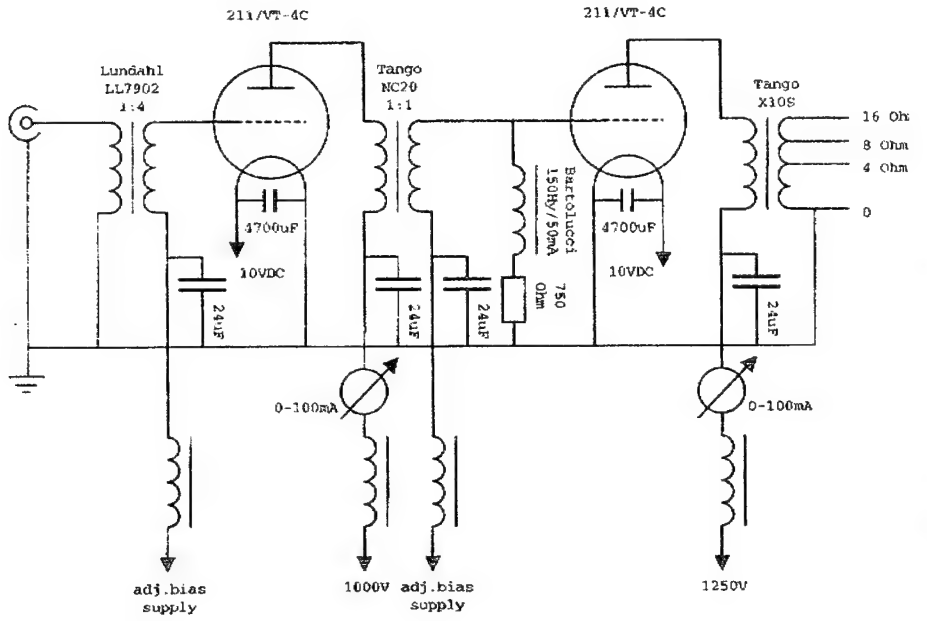
I stayed with the 211 since that very first decision, while I tried out numerous input/driver stages. The first attempts used 6SN7/6SL7 stages in SRPP and mu-follower configuration. I finally dropped these to go for an all directly heated amp with transformer coupled DHT driver stages. I tried the 26, 71A 45 and 46, the 46 being the best solution of all of these. At that stage my amp design was already heavily inspired by Sakuma's artwork. So I decided to go "whole hog" and see what it's all about with his amps using big triodes as drivers.

But there was one problem. The Tango NC-20 which was my choice for the interstage transformer would not handle the DC required by the 211, although the primary impedance would be a good fit.

211s driving 211s



The logical choice would have been a suitable Tamura transformer, but I was reluctant to buy yet another expensive piece of iron. The Tango was too expensive to get a rest on the shelf. Besides that I didn't want to compromise the frequency response of my amp. Most Tamura's have response figures in the range of 50Hz - 15kHz. This is an area where I don't follow Sakuma's approach. I want at least a "decent" frequency response from 20Hz to 20kHz.



The idea of the DC flux compensation scheme was originally brought up by a friend of mine. When chit chatting about tubes he suggested:

"You're applying the grid bias voltage through the secondary. Why not terminate the transformer with a suitable resistor to ground? The current drawn would compensate the DC unbalance in the primary."

Brilliant idea, I thought, but a quick estimate gave less than 2 kOhm for the resistor. This would load down the driver way too much. But the basic concept kept going through my mind. It didn't take too long until it became apparent to me that I only needed DC resistance below 2 KOhm. So a choke would be the perfect solution.

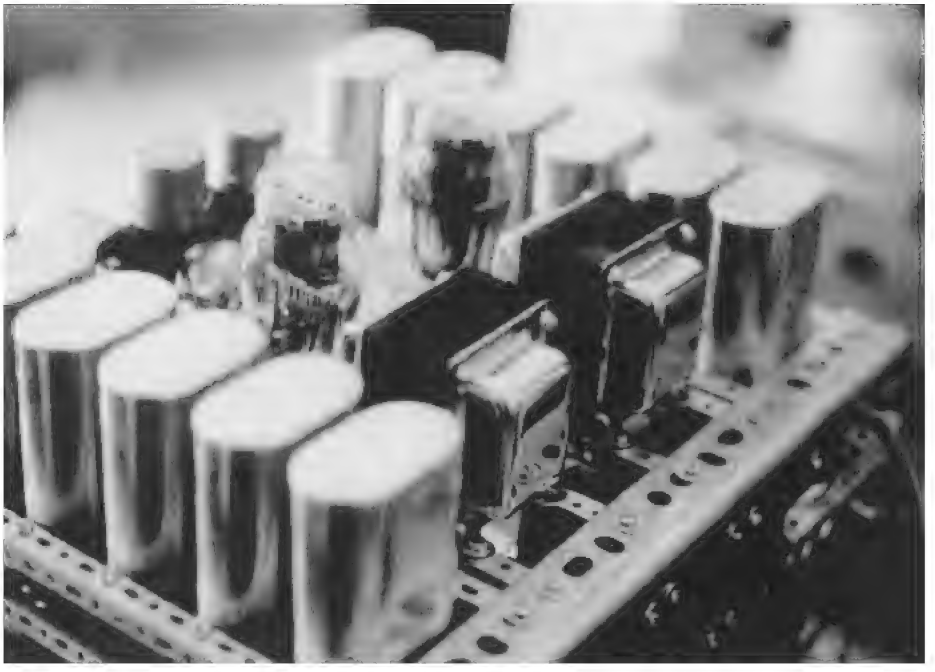
Now nothing could stop me. I wanted to hear the 211 as a driver. I dug all the chokes I had out of my parts stash and hooked them in series. All I could come up with was 80 Hy for each channel, consisting of 5 or 6 chokes in series. An additional resistor was necessary to get the right current draw. The whole mess was quickly hooked up to the amps. I ripped out the 46 and installed the Jumbo 4-pin sockets for the 211. B+ for the driver could be taken from the output tube through a dropping resistor. The power supply was oversized enough to handle the additional current.

First listening tests confirmed that this approach worked. I understood Sakuma's way of building amps. As he says in his article in *SP*13: "I understood his philosophy of life."

Despite the smallish inductance on the secondary, bass response was extremely good. The driver tube actually sees this inductance in parallel with the primary inductance. But I didn't want to stick with this experimental set up. After browsing some part suppliers' internet WEB sites, I found the 150Hy/50mA choke from Bartolucci. Perfect fit for my application. It is even wound specifically for plate load choke duty.



Above: Three-Phase Power Supply
Left: Schematic of 211/211 Amplifier



801A Directly Heated Triode Line Amplifier

The NC-20 interstage has a 150 Hy choke with a series resistor shunted across the secondary. This arrangement draws about 50 mA through the secondary from the fixed bias supply. The NC-20 is only rated for 30 mA and this DC flux cancellation trick is necessary to use the transformer with a 211 running at about 60 mA.

With the Lundahl 1:4 step-up transformer at the input, the sensitivity of the amp is about 1V RMS for full class A1 power. With the IT coupling and low impedance of the bias supply the output stage can be pushed quite far into class A2 territory.

These amps suit my personal taste perfectly. My design goal is to achieve an emotionally involving reproduction combined with high resolution and transparency.

The poly phase high voltage supply

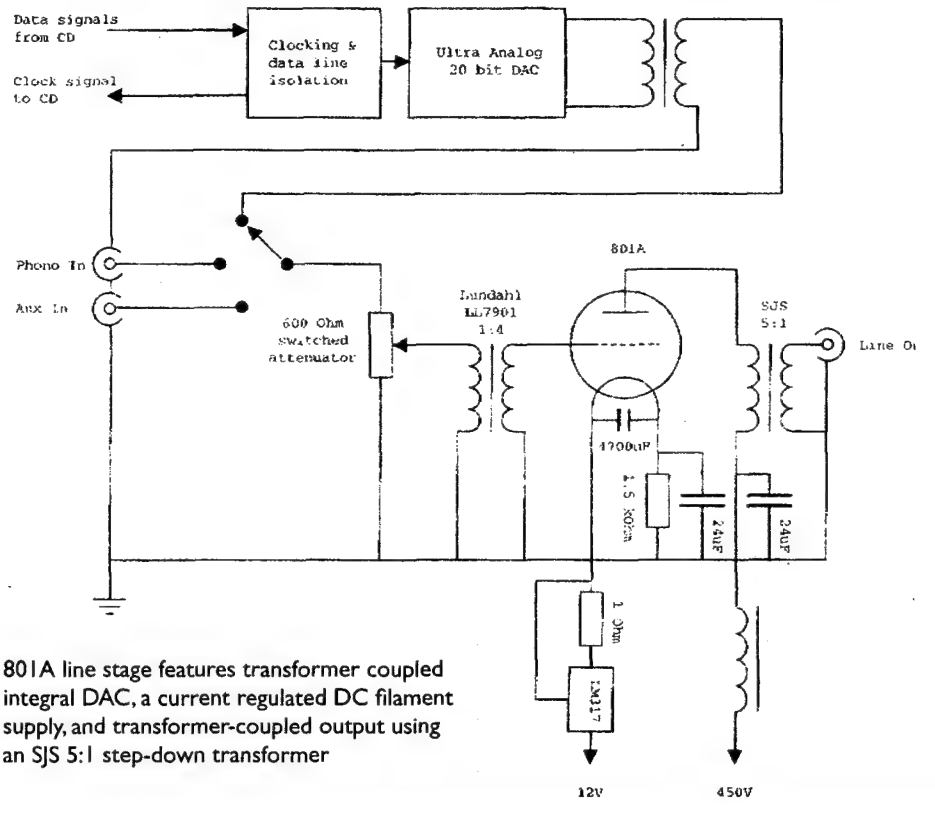
Whenever I browsed the RCA transmitting tube manual, I was always fascinated by those complex poly phase rectification schemes in the introductory section. Serious study of that subject revealed the advantage of such a supply over conventional single phase solutions: Much higher ripple frequency at the output of the rectifier and thus higher effectiveness of subsequent LC filtering stages. With three times the ripple frequency, the AC resistance is three times higher for the choke and three times smaller for the capacitor. That translates into 9 times the efficiency for a single LC stage and 81 times less ripple for a LCLC filter!

I chose the 3-phase full wave bridge configuration as this has the best ratio between transformer secondary voltage and rectified DC voltage. I had three transformers on hand which provided 600VAC and 2* 6.3VAC for the heaters. A perfect fit!

Rectified voltage after the bridge is about 1250VDC. With the six separate heater windings I could tie all cathodes of the rectifiers to their heater to stay withing maximum cathode-heater voltage ratings. Since each rectifier needs to supply only one-third of the required current, the cheaply available 6AX4GT TV damper diodes can be used.

I used a single set of three transformers and six rectifiers to supply the output and driver tubes of both channels. The supply can easily handle that current demand. A single LC filter consisting of a 10Hy choke and 24uF of capacitance leaves the residual ripple below 100mV. Not bad for a 1250V supply! Each amp has another separate LC filtering section for both driver and output, pushing the ripple into the micro Volt range.

To take advantage of such a ripple free B+ a different filament supply was necessary. I wanted to experience the complete absence of hum. Being no friend of large capacitances and since I like iron in the form of chokes and transformers I built up a DC supply for all four 211s in the amps. After achieving such good results with the poly phase high voltage supply, I tried the same approach. Six transformers along with a good handful of silicon diodes (arrgh!) provide four individual raw voltage supplies. Some dropping resistors bring



801A line stage features transformer coupled integral DAC, a current regulated DC filament supply, and transformer-coupled output using an SJS 5:1 step-down transformer



Thomas studying the tube manual in an outdoor cafe oblivious to the non-tube electronics oriented chatter of the other customers

the voltage down to the right level. Filtering is done with individual LCLC filters for each tube.

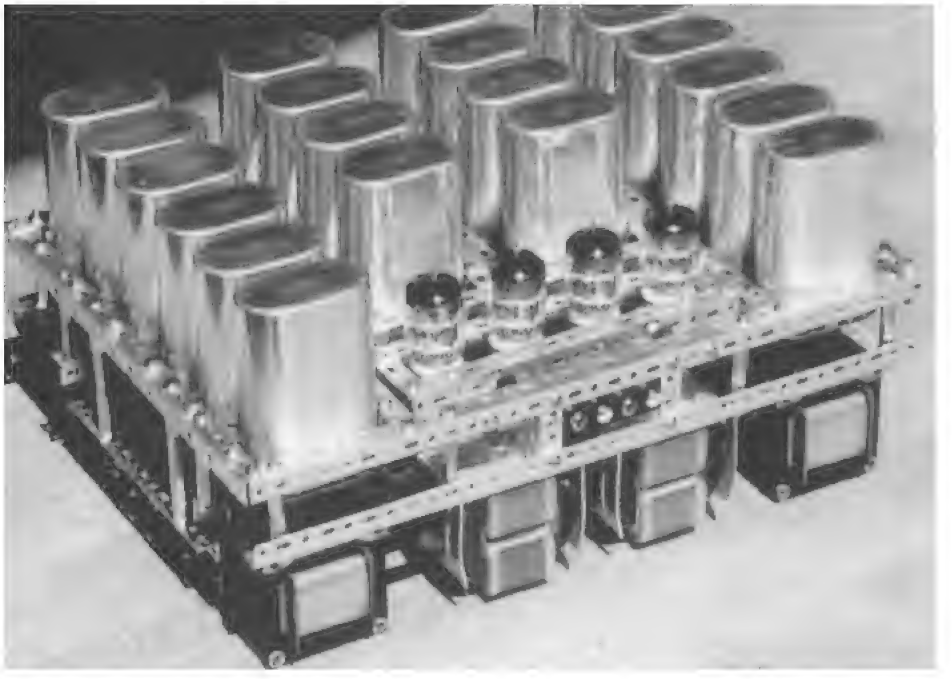
That's right, choke input filtering for the filament supply.

I bought a batch of 0.1Hy/6A chokes from a surplus dealer for this. With the double LC filtering I get away with smallish cap values (4700uF). The result is much better than a conventional supply with large capacitance values and comes sonically close to AC heating. But this silence! I thought I got used to the residual hum from AC filament supplies, but after this I won't be able to stand any hum from the filament again.

Other remarks

All other supplies (bias, line stage and phonostage) are built conventionally with 83's as rectifier tubes and choke input filters.

As you can see from the photos I use a certain kind of cap all over the place which gives all my creations a similar appearance. This is a 8uF Matsushita "phase shift" cap. I found those cheaply at a local surplus store.



From their appearance I assume they are some kind of oil filled type. Voltage rating is 660VAC and 1250VDC. A bit tight for the 211 output stage, but ok at all other places. I typically use three in parallel, 24uF being my standard cap value. I use this cap wherever the value fits. It always gave good results. Besides B+ filtering I also use it as bypass for the cathode resistor in the linestage. It sounded good in a crossover for a speaker, and a friend reported sweet and mellow mids when using it as a coupling cap in an experimental parafeed circuit.

As the amps and linestage are now past the experimental phase I'm looking for someone to create some appropriate chassis for them.

The SE 211 evolved over the last 4 years. I've tried lots of driver stages and quite a few power supply designs. For the power amp I feel I'm where I want to be. I'll only try out some different parts and maybe an 845 as the output, since the driver can easily provide the voltage swing required for an 845.

I'll definitely stay with the 3-phase power supply and I'm even thinking about trying this approach for linestage and phono as well.

The line stage is also quite evolved and I think I'll stick with that configuration and also with the 801A.

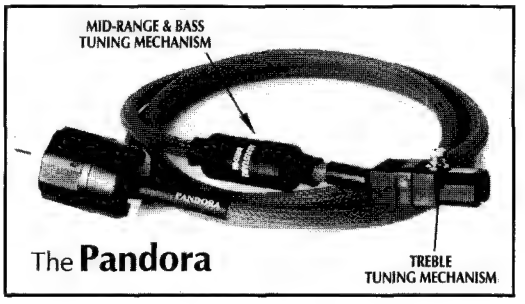
What still needs some work is the phono stage. I want to get rid of the electrolytic



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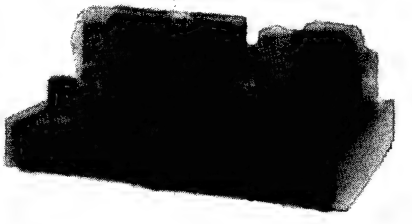
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Telefunken EC8020

cathode resistor bypasses. I have some different biasing and grid decoupling schemes in mind which can use cap values in the 8uF range (so I can use my favorite cap here). And what's finally missing are decent chassis. I don't want to stick with this prototype look.

The speakers are a design I created together with a friend back in the late 80s. It is a two way bass reflex with a unique German woofer (Podszus-Goerlich) and a French kevlar tweeter (Focal). Sensitivity is 92dB. I love this speaker for its extreme transparency. I want to try out horns some time though .

The only commercial component which I'm currently using is a Well Tempered Turntable with a Sumiko Blue Point. When the current projects are completed I'll start all over with some new stuff. I stashed away enough tubes during the last 4 years to build amps for the rest of my life.Next would be a low power amp based on tubes like the 10 or 45 to go with some horns.

The current phono stage is mainly meant as an attempt to gain experience in that field. I already got some small signal directly heated triodes (acorns and subminiature type tubes) for that. First trials proved to be way too microphonic and noisy, so I wanted to try an easier route first with indirectly heated types. But the DHT phono stage will be the real challenge!



Sound 'a la Renoir'

A Line Preamp using Type 10 Directly Heated Triodes

by Dominique Mafrand, Paris, France

Things are not always doing what we imagine them to be doing. This is particularly true with audio. We don't always understand (perhaps we don't want to?) why they are doing what they do, rather than doing what we were expecting. Either we try to understand what happened so we benefit from the smoke given off to learn a bit more or we don't want to and remain with wrong conclusions.

How many times have we experimented with designs and felt disappointed with the results? My experience was no exception. Aside from smoky designs to exploded caps, I have managed to complete some pretty good sounding gear. When I don't solder, I read audio books and magazines. Mainly *Sound Practices*. Not only do I enjoy reading it, but thanks to the mag, I designed my current preamp and power amp among a lot of other stuff.

I favor simple designs because the fewer components along the signal path, the more information goes to your speakers! In that way I have admired M. Sakuma's PP845 amp and M. Shishido's Loftin-White style 2A3 amp. These are very ingenious designs indeed because you can feel each component has been precisely inserted in the circuit. I mean the right count of right quality components at the right place, and almost best of all the minimum amount of caps. Which is not to everybody's taste. But trust them if you don't want to trust me: you do hear a HUGE difference with shrewd simplicity. This is REAL music reproduction.

If I had to summarize my choices with regard to audio, I would say DHT and permalloy transformers for preamp and amp, and paper cones, alnico magnets, and open baffles for speakers. And monophonic reproduction because listening is at least as rewarding as stereo can be, and it is less expensive! In my opinion, nothing sounds more natural and more unstressed than a combination of the above. Basically I usually go for single stage or direct-coupled two-stage circuits, and output transformers. I don't like caps of whatever technology along the signal path and try to avoid them as long as I can.

With the preamp I would like to talk to you about, I use paper cone alnico powered speakers mounted on an open baffle, fed via a Tango permalloy output transformer by an awesome sounding 10 direct-coupled to a 6072 input triode. 1500 milliwatts of pure enjoyment! A Linn turntable, a Phillips CD player and a Sony tuner are sources for the above.

So what about the preamp? I decided to design this preamp around a DHT because I couldn't understand why so few have been done before. Let's be clear: there is NO definitive reason not to use a DHT as a preamp device. Okay, let's begin the demonstration.

Basically, a line preamp gives some gain to audio signals from high impedance sources such as CD or tuner, and forwards the amplified signal to the output under low impedance. The active circuit should have gain enough to provide the amplifier input swing for full power, it should feature some input headroom not to hard clip on transients, output impedance, interelectrode capacitances of active device and noise floor shall remain low to extremely low. And, as mentioned above, component count should preferably remain minimal.

First, the gain. A DHT features low gain. It is quite absurd to have plenty of gain and to send the amp 20V if 1 or 2 induces amp output clipping! Just send what's enough and that's all.

What about transients, one could ask? Your amp has to work with all the energy the preamp sends: either it works great or it clips on transients hence adapt the gain according to your gear!

Secondly, input headroom. A DHT compared to small-signal triodes needs higher grid voltage at an identical operating point. Therefore, it is no big deal to prevent input clipping by biasing the active device accordingly. By the way, select a DC operating point at high plate voltage and high plate current to keep distortion under control.

Thirdly, output impedance. Not a problem as we are going to use an output transformer. Note that the primary impedance of line output transformers is generally far higher than the plate impedance of DHTs so bandwidth gain will benefit from this. I will come back later on this.

Fourthly, interelectrode capacitance. The grid-anode capacitance (C g-p) is the most difficult point to be addressed. DHTs show high C g-p, but single plate DHTs are good candidates for the job, like the 10 (8pF) or 45 (7pF) for example. Consider them like two 5687 (4pF) in parallel.

Fifthly, noise floor. DHTs heated with pure DC current are as quiet as are any other indirectly DC heated tubes, so just carefully design your high voltage power supply like you usually do.



The Twins...sleeping. RCA 10 in the amp, Sylvania 210T in the preamp.

Conclusion? I chose a 10/VT25 DHT because it has a moderate 5k plate resistance, a sufficient amplification factor of 8, and C g-p is on the low side at 8 pf—plus, I have got some on the shelf! We can do it, folks, we can do it!

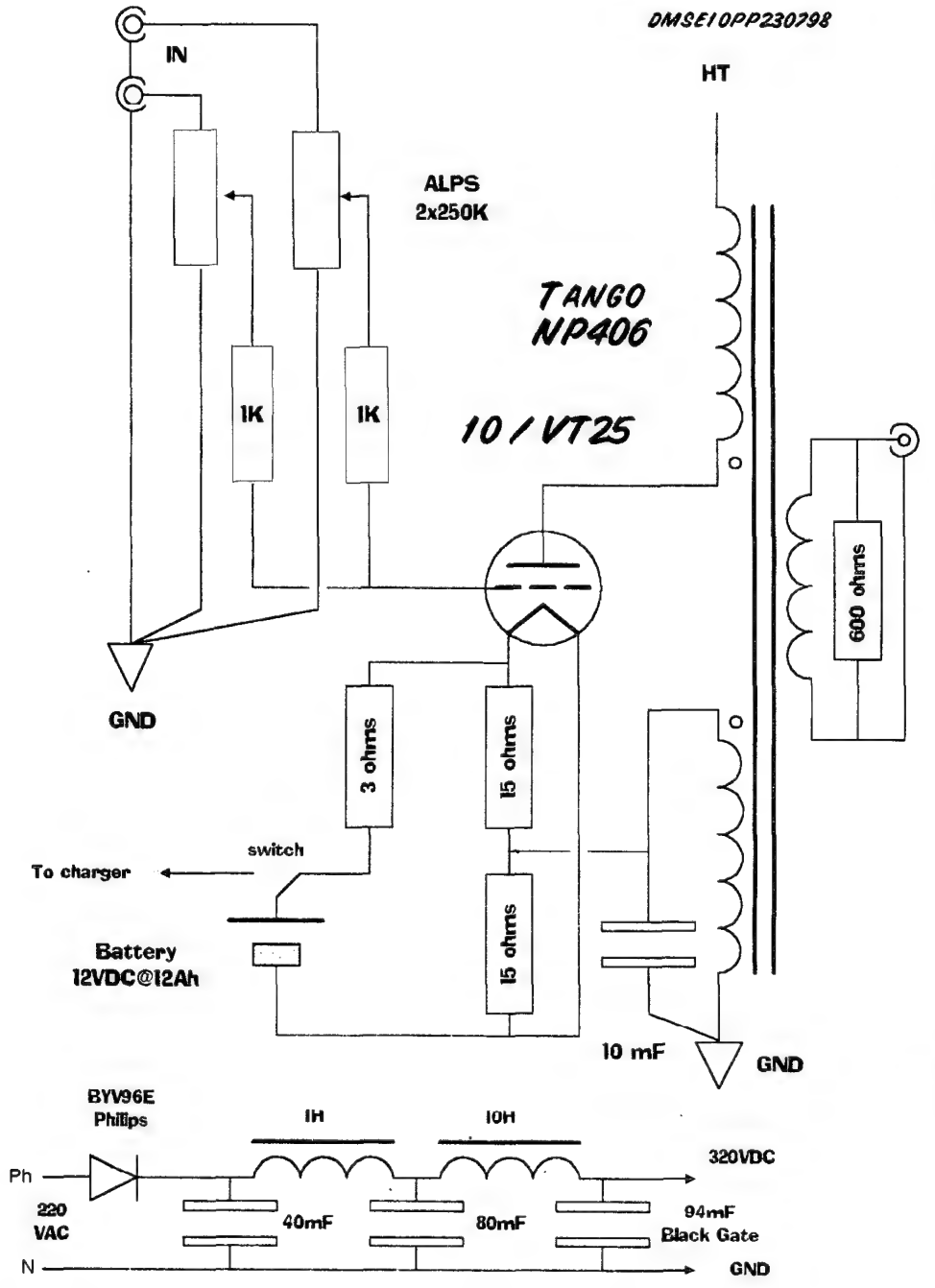
THE CIRCUIT

This original circuit has been designed using all of the above rules. It consists of a single 10 whose grid is connected to the stereo (!) input pot wiper via two 1K resistors acting as a stereo-mono passive converter (I'm thinking about increasing that value).

One could think now to connect the DHT plate to a SE line output transformer and use a DC heated filament to a bypassed bias resistor through a center tapped power pot.

Well, things are not always like one expects. Instead of using a SE x-fmer I have thought about putting a PP x-fmer with one primary half winding as the output x-fmer and the other half as a biasing device. This choice has been considered for various reasons:

—DC resistance values can be kept low thanks to the use of transformer windings you can compare to choke loading, enough to bias and to get huge input headroom.



—Transformer gain is increased by 2 because we work at a constant number of turns on the secondary, but only half of primary turns is dynamically involved.

—Primary half winding impedance is high so a low decoupling cap is enough, and the transformer primary windings will be biased automatically with strictly identical DC current ! No grid current drawing on my 10, but it has to be checked on other samples.

However, our output x-fmer must be of the highest quality, that is to say super-permalloy core with very high permeability, because it will work in single ended mode but with the main push-pull x-fmer trade off: non linearity of flux density which induces secondary signal when magnetizing force is very low.

Remember, DHTs don't have much gain so plate voltage won't reach extreme values. Only very high permeability material can help because the hysteresis loop is extremely tight and the slope is steep hence even very low excitations will generate flux variation without audible distortion.

How lucky we are that Tango happens to manufacture this kind of scarce jewel under part reference NP-406N. Let's see the technical chart:

— Core is 78% permalloy, bandwidth with 5K plate resistance of a 10 is about 5 Hz- 80 Khz at +/- 1db, not bad!

— Maximum primary DC current = 40 mA with 1 mA max. unbalanced, okay.

— Primary half winding DC resistance = 540 ohms,which is good.

— Primary half winding AC impedance = 20 Kohms, very good.

— Secondary impedances are 150 and 600 ohms, 600 will be excellent.

— Voltage ratio is 1: 0.123 for full primary winding and 600 ohms output tap, so we are good for a 1: 0.246 in our application, fine.

— And maximum secondary voltage is 3 V RMS, just right!

Okay, we can calculate the average overall gain of our preamp. Average *mu* of the 10 is 8, average plate resistance is 5 K, so as we decouple the filament load overall gain is:

$G = (\mu * Rl / (rp + Rl)) * X\text{-}fmer\ voltage\ ratio = (8 * 20 / (5+20)) * 0.246 = 1.57$

That is to say 1 V under high impedance at the input will give 1.57 V under 600 ohms at the output. We have got it! My amp needs about 0.8 V for full output as many amps do, so 1.57 V is

enough to drive it into overload!

This apart, the 10 is working at about 292 VDC plate voltage, 26 mA DC plate current, and it is biased at –14 VDC. With a dynamic load of 20 kΩ, the plate voltage and current swing are in a very linear part of the characteristics, so distortion is very low, the triode works far under the max. power dissipation excess, so we can expect an unusual long life for a DHT, and the grid voltage allows plenty of headroom, so no stress at the input. Note that the low gain and low Cg-p help minimize Miller effects.

The ground is star connected. All returns are soldered at the negative terminal of the reservoir cap. I found this method to be as humless as Mr. Sakuma's 2 point ground or Diego Nardi's buss ground method. Secondary winding has no ground reference and it is loaded with a 600 ohm resistor, helping the preamp to act independently of interconnect and amp input loading.

I hate measurements. I just check what is necessary for the circuit to perform well, and then only trust the listening tests. It has been worthwhile so far. So don't be mislead with impressive figures, we all listen with our ears not our eyes, don't we?

POWER SUPPLIES

I use a transformerless cap-loaded power supply designed around a single solid state rectifier connected to the mains phase and followed by one smoothing cap, then two LC filters in Pi configurations. Ground leads are to the mains neutral.

We are lucky enough in France to have a 230 VAC mains voltage so a good PSU can provide you about 330 VDC with very low ripple. Solid state rectifiers can sound great provided you avoid transformers! Have you ever monitored voltages at the outputs of a tranny when rectifiers are rectifying? You understand a lot of things after that. Either you try to fix it using John Camille techniques (SP #7), for example, or you do without a power transformer. Also, all noise and vibration caused by a transformer are avoided too! Free bonus!

NOTE: Transformerless so-called AC-DC supplies such as this are quite DANGEROUS and should not be attempted by experimenters unaware of the hazards involved and proper precautions to follow. It is not worth dying to avoid switching noises in the power supply. Use of a transformer for isolation from the AC line is highly recommended for safety. Anyway, in the US we'd need a step up trans to get to 220V, or you'll have to unplug the clothes dryer and plug in the 10s!—ed.



Under the bonnet

Filament is battery-supplied via a 3 ohm power resistor adjusted to provide 7.5 VDC as required, and two 15 ohms 2W resistors provide a center tap for bias connection. You want quiet, you get it!

PARTS AND CONSTRUCTION

I am currently trying various brands of 10 including RCA, Hytron, Sylvania, GE, Western Electric, Visseaux and Neotron both from France, but I haven't got final conclusions yet. I have 10, 10Y, VT25, VT25A (*in*directly-heated, cathode-type triode—ed.) and 210T types. I will let you know.

Other fundamental parts are as follows. Resistors are from VISHAY, the best sounding to my taste. Decoupling cap is a 47 mF ceramic powder Cerafine type from ELNA. Others tests will include Black Gate and expensive Teflon REL-CAP. PSU caps are polypropylene from SIC-SAFCO, France, for the first Pi section and a great Black Gate SKZ type as audio reservoir at the output of the second Pi filter. The pot is from ALPS, but I will probably swap with an Arn Roatcap's or Audiolive's beauty soon. Internal wiring is Kimber Kable TCSS pure copper which I recommend as the best quality-to-price ratio.

Battery set is 12VDC at 11Ah from YUASA and integral charger takes care of battery charging when the preamp is turned off.

Chassis is all made of waxed wood and screws. An insulated enclosure is necessary for a transformerless design to prevent body contact with the electrically hot chassis. Total weight of the preamp is 12 kg or 26 lbs.

LISTENING

Listening to this magic mixture on an open baffle speaker is quite amazing, believe me. The main speaker is a paper cone TRIANGLE full range speaker connected without filters. Note this speaker is faster than a LOWTHER PM6A or C and as natural as these English classics. High frequencies above 12 KHz are reinforced by a paper cone G.E. tweeter from the fifties, and its alnico magnet gives the music that unequalled touch of life.

My favorite musics are jazz, classical and opera. I listen to rock and pop too but I find pop recordings and mixes so unnatural, so chaotic and so different from one disc to another that I am often disappointed, so I don't purchase many.

You guessed it— the system is unforgiving, if the source is poor, then you will listen to poor reproduction. But if the source is of high quality then you go straight forward to heaven. This is "in the flesh" reproduction, alive like a Renoir painting is alive. You miss no detail, you can touch everything if you hold your hand out.

The trial has been worthwhile, I tried and now I can say: yes, man, DHT and high perm core in preamp circuits do convey true emotion. DHT is emotion, delicacy, life, and no doubt DHT/permalloy will remain unsurpassed as an answer to the true audio quest! But remember—The most fundamental aspect of audio homebrewing is to have plenty of fun! And you can have plenty of music too, if you follow up on your inspiration.

THANKS TO:
All the parts suppliers including Angela Instruments, USA, The Parts Connection, Canada, Audio Note UK, Sound Shop Big, Japan, and Radio Tubes France.
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Joe Roberts, **SOUND PRACTICES**, Issue 6

THE ULTIMATE CAP

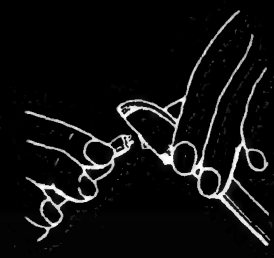
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Diego Nardi's comments on Allen Wright's comments on some comments made earlier by Diego Nardi...

plus...

The MONOphono Preamplifier



by Diego Nardi, Audio Note Italia

I'd firstly like to thank Allen Wright for his appreciation and his criticism on my φ42 design. I like this kind of constructive debate and, therefore, I'll express some thoughts about the points Allen made, one by one.

1) Agreed.

2) Two points: Number one is that high transconductance tubes like the 417A are very attractive at first sight, but they pay a big price for their apparent ability to "resolve charge levels on the order of an electron"[?!]. The first one is that their linearity is rather poor. Also, they can only stand very limited plate voltages on the order of 100V. The only point about high current is that you must use a very low value/high dissipation plate load resistor. That makes for distortion in both the resistor and the tube—low level operation is no excuse!

The second one is that, in order to obtain 25 mA/V, these tubes have their electrodes *extremely* close together and their frame grids are wound with micron-thick wire. The problem with this is that, despite their very accurate and sophisticated construction, due to inevitable mechanical tolerances, the sample-to-sample consistency of their parameters (which is critically dependent on the inter-electrode distance) is very poor and varies widely with temperature, age, and vibration—a complicated way of saying that they're also very prone to microphonics. Not to mention mediocre cathode-to-heater insulation resistance and relatively short life. To me, the highest transconductance tube that is really useful for audio signal is the 6DJ8/6922, but due to insufficient amplification factor and microphony, it is at its best as a power amp input stage, and I discarded it for phono input.

Conversely, the 12AX7 and—even better—the 6SL7 and the 12AY7/6072 may only have 1/20th the Gm of a 417A, but they are usually loaded with a twenty to forty times higher value load resistor, dissipating fractions of a watt with less thermal noise and no temperature coefficient problems.

Most importantly, these are audio-specific tube designs and they have better heater/cathode insulation, "infinite" life (systematically exceeds 50,000 hours and easily reaches 100,000) with satisfactory consistency and *way* better linearity.

Identifying high transconductance with high resolution *tout court* is nothing but a commonplace in my opinion, and substantially wrong if you look at loading requirements. There are other factors that matter more.

I regret that I took it for granted in the φ42 article, because the high transconductance guys seem to have missed it completely. While it is true that the input impedance of the EQ network should not overload its driver, *it must load it!* Otherwise, the current that the tube modulates will do nothing but heat the plate resistor, no matter the Gm. Nobody seems to care about this. In the φ42 (*SP*#14:p.30), you will notice that R4 is only about 1.6 times R2, while in Allen's design (*SP*#15:p.39), this ratio is close to 10, and in the Loesch (*SP*#3:p.26), it is close to 20 in the 75 network and around 6 in the 3180/318 network. This way, the advantages of a high Gm stage are largely thwarted.

3) I do get RIAA paper caps matched to my specs, of course, and I can supply matched sets as well. Having said this, after quite a few years of screwing around with RIAA stages, chasing perfect accuracy like an idiot, I have come to the conclusion that +/– 0.5 dB from 30 Hz to 15k and +/– 1 dB above and below is all that's needed. Better accuracy than this, all other circuit parameters being the same and channel tracking being accurate, is of no interesting consequence sonically.

4)Load a high mu triode first stage to the criteria explained in point 2 above and you'll get "air and naturalness" with no need to resort to this trick.

5) I have seen too many star-wired amps turn into FM transmitters. Star-wiring is maybe OK on PCBs, but it is a big pain in the butt when it comes to hard-wired circuits of substantial size like the φ42. The physical size of the components forces one to make ground returns of some length, introducing a number of parasitic inductances you can't prevent from coupling together in a way that is virtually impossible to control, no matter how you mess with the layout. Even when the thing doesn't oscillate at 140 MHz, as recently happened to a friend of mine, the risk of "cat piss sound" is right around the corner. If you want to build my circuit, stick to buss grounding please.

6) It seems nobody has ever had any luck with cathode followers except myself and Kondo-San. When he came to Italy last year to visit Audio Note Italia, I asked him why. His very wise answer was that there's nothing wrong conceptually with cathode followers; it's the application that is tricky. I entirely agree.

The cathode follower has a low output impedance but it is not more load tolerant than common cathodes. So what? The whole point is using it properly and, if it doesn't work, this is the fault of the designer, not the circuit, period. You must look at the circuit as a whole, not as a pile of Lego

bricks. In this specific case, I purposely optimized it to work in a certain way and for a very specific purpose.

Allen's suggestion to remove it is extremely awkward, takes for granted that an interconnect is a "high-quality" capacitance (which is miles away from being true compared with a good cap of the same value, especially regarding mechanical factors and series inductance), messes up the loading on the second stage (which is guaranteed to mess up the sound), and is entirely pointless overall.

The biggest threat to all these theories that the cathode follower itself is supposed to sound evil—a point, by the way, which I have never found to be supported by any positive argument but the usual "It's a 100% feedback circuit and sounds bad" bullshit—is the sound of Audio Note Japan gear. Funnily enough, despite this, even the Audio Note UK people love to spit on the CF...

Please disregard the gossiping and leave the CF where it is...or make your own design.

7) You *must not* use the components to "find the sonic flavor you like." This is equivalent to destroying all the work you've done to try and get the circuit OK. It's already bad enough to set up the circuit "conceptually" in order to have the least sonic flavor of its own; components should be chosen to add as little as possible. If you want to intentionally color the sound, it's cheaper to bugger around with circuit parameters than components.

8) Removing electrolytic capacitors is not a cure-all, and pretty often does more harm than good. Cathode caps in particular are, in my opinion, often not replaceable. Unbypassed cathode resistors effectively rob transconductance, and all alternatives that have been proposed are guaranteed to drop you from the frying pan right into the fire. Diodes and LEDs put in lots of distortion resulting in a horrible gritty sound, batteries have inconsistent performance and cancel out lots of low-level information, and film caps of the required values are often worse than electrolytics. Much the same holds true for decoupling caps. They act as "local batteries" and an electrolytic does it better than an actual battery. Use Black Gates or Cerafines if you want the best, but look at the design as a whole and leave blind integralism to the Middle East terrorists.

9) I never spent much time experimenting with voltage regulators, mainly because I never came across a regulated preamp that I liked. I have tried Counterpoints, Conrad-Johnsons, Audio Researches, a Lazarus, a Convergent, maybe others I don't remember, and I wouldn't live with any of them.

Maybe this has to do with the fact that all fancy voltage regulators are very high feedback amplifiers and often rely upon cheap IC opamps running open-loop or nearly so, a situation in which their distortion is NOT low, despite the good specs on the datasheets. High-gain error-amplifiered preamps I have heard all had a sort of mechanical/artificial, very "audiophiliac" presentation which is exactly what I am trying to avoid, and that made me skeptical about them.

However, I would be curious to give Allen's *Super Reg* a try and I have the diagram and setup instructions, but no time to draw up a PCB for it. Hey, Allen, couldn't you just send me a photocopy of the PCB layout so I can etch myself a board? My address is in *SP*#14.

A few more general notes: Cascode-configured input stages do offer some advantages—essentially very high and easily adjustable gain—but their gain and distortion characteristics are more load dependent, which makes them less suited than high-mu triodes for the loading strategy that I like best. I happened to use a cascoded 6922 as the input stage for a small power amp *(Costruire Hi-Fi #29)* and in this application I did get good results. Besides, the very first phono preamp I ever designed used a 6DJ8 hybrid-cascoded with a transistor, but by now cascode is no longer my choice for a phono input. More gain than you can get from a φ42 is of no useful interest anyway. Direct amplification of signal from MC cartridges in order to save the expense of a good step-up transformer is a loser strategy to me, as I have already argued. The only worthwhile MC cartridges are very expensive and so deserve a transformer. Budget MCs have too many flaws and they're battered by similarly priced fixed coils very easily, so why look for an MC direct preamp?

The MONOphono

After all this talk show, I want to show you something dedicated to record collectors. It's a MONO phono stage conceptually derived from the φ42and designed to play mono records, whatever they are, LPs, 45s, and 78s. You don't need a mono cartridge or a specially set-up playback system, at least if you only want to play microgrooves. You can use the same system you play stereo LPs on. Of course, you will need a turntable which will spin at 78rpm (preferably with a pitch control) and a cartridge equipped with a suitable stylus if you want to play 78s. A few manufacturers still offer 78 rpm styli for their cartridges—for example, I use a Stanton 681 with 6827 stylus for this purpose, mounted on a Technics SP-15/SH-15/EPA-250 system which also wonderfully plays my stereo LPs (equipped with an Audio Note IQ-II).

Direct drive??? Yes—and direct *sound*. No more audiophile bullshit, i.e. vibrating motors, irritating start-up times, slipping belts, wow, rumble, awkward suspensions, motor and platter tweaks. Just music, positive, strong and pure. Enough said. The arm does require a bit of tweaking to work properly, however.

The Monophono offers a choice of six treble cuts (flat, 20, 50, 64, 75, and 80 microseconds), six crossover frequencies (318, 400, 450, 530, 630, and 880 microseconds), and two bass cuts (3180 and 1590 microseconds), for a total of 72 combinations. Although the 1590 bass cut is rarely used (only some Columbia LPs require it), the other time constants allow you to compensate for virtually any recording characteristic ever used. You get the RIAA/New Orthophonic (318+75), the CCIR(450+50), the AES (400+64), the London 78 (530+75), the Decca FFRR 78 (880+20), the EMI 78 (630+flat), and so on.

Don't worry about records whose recording characteristic you're not sure about: try switching the bass lift first, then the treble cut, and you'll easily find a setting at which the sonic balance is obviously most correct. It's easier than you might think. You'll find that the majority of LPs are to be played with either the RIAA or the AES, and most pre-1970s 45s sound best on AES too. 1950s 78s are generally played back with CCIR, while the situation is more varied with older ones. Most often, the optimum setting will have to be determined experimentally.

The circuit has two parallel inputs and two parallel outputs in order to be plug compatible with a stereo system. You don't need to bugger around with cartridge connections since the generators will be paralleled at the preamp input. This will cancel out the vertical modulation output, with the side advantage that all of the components of surface noise, impulse noise, and, most importantly, mistracking distortion engraved on the grooves by previous poor

tracking that are modulated vertically will be rendered inaudible also. Many old records that sound badly battered if played in stereo become much more listenable if played back in mono.

The use of a stereo cartridge for 78s also offers the possibility of playing back ancient "hill and dale" vertically modulated records. To do this, just reverse the connections of one channel at the cartridge pins—choose the channel with no ground tab, usually the right channel. In this way, the two coils are connected out of phase and, therefore, when paralleled, they output the vertical modulation. Note however that these records can have grooves of strange shape and may be difficult to track.

Another advantage of using a stereo cartridge to play mono records is that it'll track 'em much better.

The circuit uses only two tubes, one 6SL7 and one 6J5. If you can't find a 6J5, you may use one section of a 6SN7 instead: it makes no difference apart from heater consumption.

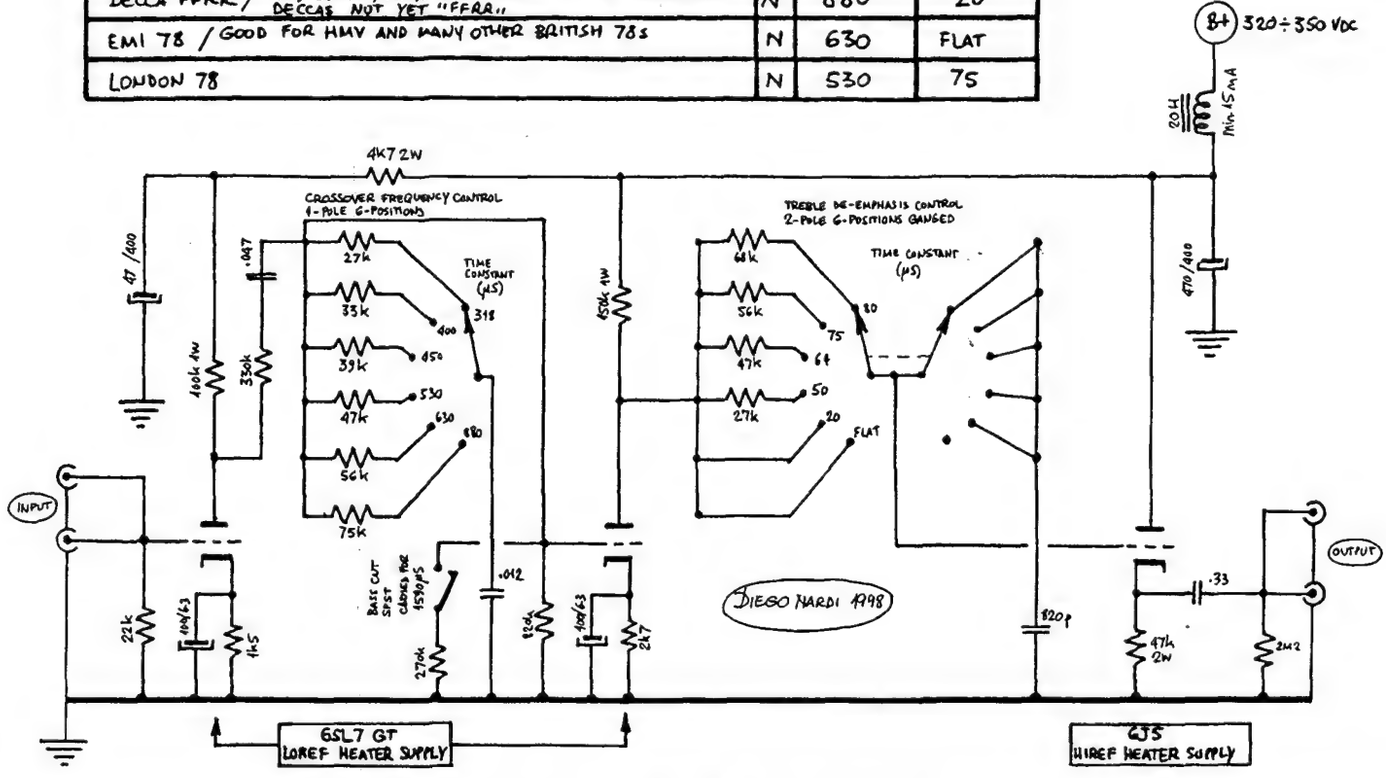
In order not to add an extra tube, I gave up to SRPP in the second stage, but I biased the two 6SL7 halves in such a way that input acceptance is still ample. Please don't cultivate the illusion that common cathode sounds any better than SRPP. This is not true and it is claimed by those who make SRPPs with two sections of the same tube and/or a common heater supply. This is what really degrades the sound of SRPP. The circuit itself is excellent if properly biased. Please note that I don't agree with those who "load it down" to decrease static measured distortion. This robs dynamics.

This circuit is designed to run from the same power supply as the φ42. I suggest that it is a very convenient idea to construct a flexible phono preamp with both the φ42 and MONOphono boards sharing the same chassis and power supply. I found that this solution does not in the least degrade the sound of either, provided that signal switching is avoided. Route the stereo and mono outputs via individual interconnects to two inputs of your line preamp or integrated amp, and connect the turntable leads to whichever circuit you intend to use.

Have fun! Diego



SETTING / NOTES	BASS CUT	X-OVER	DE-EMP
RCA "NEW ORTOPHONIC" / LATER STANDARDIZED BY RIAA	N	318	75
COLUMBIA LP / THOSE THAT ARE NOT TOO OLD OFTEN SOUND BETTER ON NEW ORTOPHONIC SETTING	Y	318	80
AES / GOOD FOR SEVERAL (NOT ALL) PHILIPS, DG, ARCHIVS OF '50'S AND '60S AND MOST PRE-1970 45'S	N	400	64
CCIR / 1950'S 78S ARE ALL SUPPOSED TO COMPLY, ALTHOUGH NOT ALL ACTUALLY DO	N	450	50
COLUMBIA 78 / SUPPOSED TO BE GOOD FOR SEVERAL AMERICAN 78S	N	530	80
DECCA FFRR / 1949 CURVE, PLAYS WELL ALSO POST-WAR AMERICAN DECCAS NOT YET "FFRR"	N	880	20
EMI 78 / GOOD FOR HMV AND MANY OTHER BRITISH 78S	N	630	FLAT
LONDON 78	N	530	75



THE MONOphono - A RECORD COLLECTORS' PHONO STAGE

The MV-45 Convertible



by
Steve Berger, Aprilsound

What to do with that
old burnt up c-j chassis

I know very little about electronics, maybe just enough. Everything that I have learned has been through the kind generosity and patience of the likes of J.C. Morrison, Herb Reichert, Arthur Loesch, Noriyasu Komuro, Tadataka Uchida and some of the writers in *Sound Practices*.

I think that the only reason to have a music system is to listen to MUSIC! Now, if some piece of hardware will get you to listen to music on a more regular basis, I'm all for it.

I enjoy hearing Lester Young's chorus from an old Columbia rerelease of the Basie band playing "Tickle Toe" or Schnabel playing "Kinderszenen"



or possibly something from "Still Crazy After All These Years", none of these being great recordings, just recordings of great music.

My point is that, it's not the recording, it's where the recording takes you that is the most important thing.

These machines can, in the hands (or in front of the ears) of the right person, be transportation devices, even time machines. Where they take the individual is up to the ticket holder. Whether it's to Kansas City or Thailand, 1965,'35 or 1765. Whether it's in a VW, a "K" car or a Rolls, they all get you there. I personally think what I'd like is somewhere between an Alfa 1800 and a Mercedes 300. Ya know, something that will handle those curvy mountain roads with aplomb and still feel like home at 160 kmh on the autobahn.

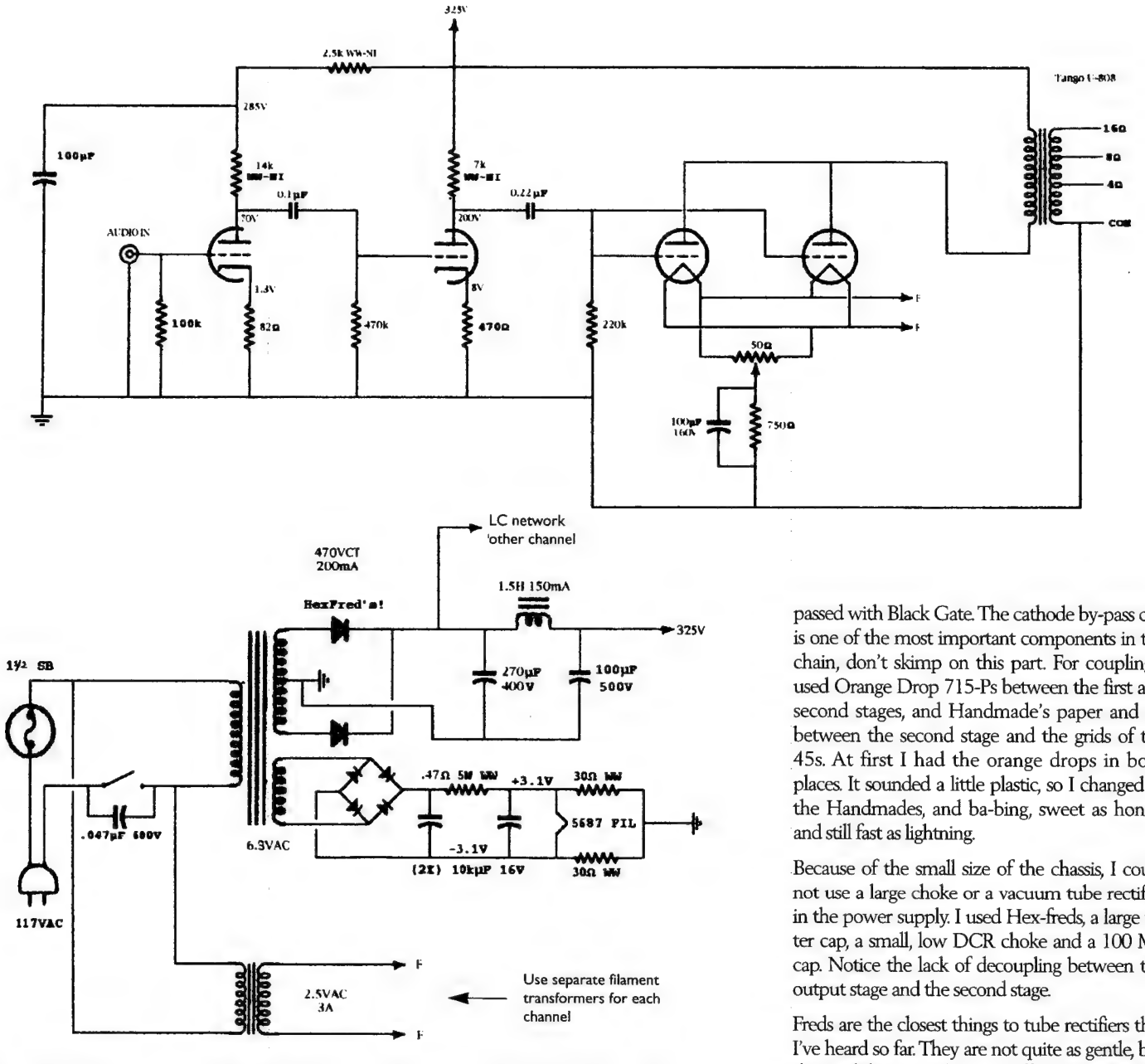
In designing an amp, speed, agility and good tonal balance are the orders of the day. The name of this amp, MV-45, is kind of a joke (Get it? Multi-Valve-45). I was called by a man who had just obtained a pair of Klipsch horns. I immediately said, "All you need now is a nice little 45 amp." He said, "What's a 45?" Anyway, he didn't want to spend more than $2000 (we ended up trading for a Marantz 10-B) on an amp that he had never heard of, so I started looking around for on hand parts. The first part being a chassis, this is where the MV-45 comes in. It was originally a standard kind of Stereo PP EL-34 beautifully made, nice chassis. I had to figure out what to use all the holes for. I knew that I wanted to use U-808s (one of Tango's less expensive universal trannys) for the OPTs since I have them. These are possibly the most sold OPTs in Japan and they are inexpensive. Next was a beautiful Mil-Spec PT 480VCT @ 200ma. Once I had these things I knew I was on the way.

I was going to make it a single 45, but that would leave a couple of big, gaping holes that would be nice to fill. Another good and much more important reason for paralleling was so that I could use the whole secondary of the OPT. It is much easier to design and build a hi-Q OPT with wide bandwidth with a lower primary impedance than with higher primary Z. The reasons are obvious. Since a tranny is a ratio device, if you use a smaller ratio from primary to secondary, the windings can be closer in size and hence closer together. You can achieve a closer coupling with less stray capacitances and less losses.

Time is of the utmost importance! We sense shift in phase as either sluggishness or confusion. This is not what we want! An amp that is truly elegant has a sense of spatial coherence. That is to say things seem right in time AND space. This sense is a direct result of *phase coherence*.

For these reasons, what I think we want is WIDE bandwidth. Not because we can hear 20 to 20,000, but because we can "sense" 5 to 105000 as phase shift.

This amp is not going to get us 5 to 105000 but it'll get us a lot of the way there. I measured this amp 3 dB down points at 17 Hz and about 80 kHz. You will notice that it's closer to ideal on top than it is on the bottom. This is OK because our ears are more forgiving in the bass than on top. This has to do with the apparent hypersensitivity to frequencies between 2 kHz and 4 kHz (Fletcher-Munson curve). To avoid any noticeable phase shift (distortion) through this region, we would like to have an amp that goes an order of magnitude or more farther out. I'm of the opinion that if you can achieve a nice tight, well controlled, coherent mid bass, your ears will fill in the bottom. If not, BI-AMP! This is really the right way to do it anyway. In my experience, I've never heard a single, truly full range amp, or speaker. Unfortunately, I don't have such luxury as a system that goes to 20 hz living in a New York City apartment. So, I make do with a modest system with beautiful mids, graceful highs



and a nice tight, well proportioned mid bass down to about 60 hz. I digress. If you look closely at the schematic, you will see that it bears a strong resemblance to Herb Reichert's famous "Flesh and Blood". To me it's got so many aspects in common that I was considering "Blood and Guts" as its name. It follows a lot of Herb's rules.

This is a classic, three stage, RC coupled amplifier. I chose the 5687 as the voltage amp and driver for its very straight plate curves and its low RP. Its ability to drive difficult loads makes it an ideal choice to drive a pair of 45 grids. When operated with LOTS of current going through it, it has a very rich, uncolored sound.

I tried to get the widest bandwidth I could out of the first two stages. To achieve this I pulled out *SP* #2 and turned to Crowhurst on "Load Lines". Man, what a GREAT article! Armed with this information, I was able to calculate the values of all the resistors in a flash. I wanted to get my load line right in the middle of the straightest part of the plate curves. Old Norm got me right where I wanted to be. Testing the driver stage with the output tubes pulled out, it tested flat from as low as my test gear will go (10 hz) out to 500 kHz. I attribute this to the use of very small plate resistors, and the inherent linearity of the 5687.

My choice of plate resistors in high current stages is 12 watt, Mills non-inductive wire wounds. I think these are the most un-mechanical, sweet sounding resistors for plate circuits. For grid and cathode circuits, I prefer AB carbon comps. In the cathode of the output tubes, I used 25 watt Dale non-inductive chassis mount resistors, by-passed with Black Gate. The cathode by-pass cap is one of the most important components in the chain, don't skimp on this part. For coupling I used Orange Drop 715-Ps between the first and second stages, and Handmade's paper and oil between the second stage and the grids of the 45s. At first I had the orange drops in both places. It sounded a little plastic, so I changed to the Handmades, and ba-bing, sweet as honey, and still fast as lightning.

Because of the small size of the chassis, I could not use a large choke or a vacuum tube rectifier in the power supply. I used Hex-freds, a large filter cap, a small, low DCR choke and a 100 MF cap. Notice the lack of decoupling between the output stage and the second stage.

Freds are the closest things to tube rectifiers that I've heard so far. They are not quite as gentle, but they exhibit a similar turn-off characteristic to tubes in the sense that they don't make a big EM spike at turn off. I believe that this spike is at the root of the horrible "solid state" sound that we've all come to know and hate. The up side of using SS rectifiers is that they have a very low impedance. This can have an important impact on the overall speed and coherence of the amp. I believe the next generation of SS rectifiers will probably be even better. I know, I know, this flies in the face of everything we hear about SS rectifiers. But, as J.C. always says, "There are a hundred and forty-four ways to make a great amp!"

This amp gets right to the heart of the matter. It's fast, it's honest, it's direct. It's so direct that it doesn't sound like a power amp at all. It has a quality closer to that of a really good pre-amp. I

think that that's the 45, because as soon as you drop in a pair of 2A3s it sounds like a power amp. Did I forget to say you can just drop a 2A3 into each channel? That's the convertible part of the title.

Build this amp! It's simple, it's elegant, it sounds great! If you want more romance, try globe 45s. Or have a romance. Use what you have. Use your heart. Use your taste! Amps really do mirror their makers. (Scary thought, isn't it?)

Notes from the other side of the MV 45 deal by Dorwin Gregory

He traded a Marantz 10B,
so good thing he liked it

Although I've written a lot of poetry and audio has been one of the great loves of my life, I had never written poetry about stereo sound reproduction or music, let alone "to" an amplifier. I just didn't look at stereo that way. Thanks to making the acquaintance of amplifier designer Steve Berger, my recent introduction into the secret world of SE amplifiers has changed all that. I have to confess, before that time I had never listened to a SEDHT amplifier, although I had read a few reviews in the popular audio press.

Paul Klipsch once wrote that what this country needs is a good five watt amplifier. Even at 104 db/m, four triode watts could not reproduce full orchestral music at realistic listening levels. It would play it but with a cameo-like diminishment of scale reminiscent of exquisitely painted illuminated Persian miniatures. To my taste, the four watt output of the SE 45 couldn't do one of the things which the Klipschorns do best: act like giant pumps to effect effortless and instantaneous pressurization and depressurization of the room air. I then tried biamplifying the Klipschs with the SE45 on the midrange horn and tweeter crossing over at 400 cps (6 db/octave) to the bass horn driven by the Tilden OTL, OCL 6336A triode monoblocks. These put out about 15 watts into 16 ohms, more than enough for the K Horn bass. The bottom octave is covered by two 15 inch Altec Subwoofers driven by Threshold Stasis1, no feedback monoblocks.

One of the first things I began to notice about Steve's amp was how different the imaging was from other amplifiers I was familiar with. Years of listening to OTL amplifiers have made me accustomed to an extremely wide, wall to wall, rock solid soundstage extending between the speakers and receding layer by layer behind them into the far distance. Instruments and musicians have precise spatial locations and appear as sonic holograms or fixed phantom images. The Multivalve 45 not only is a master of spatial depth, but it projects the sound forward, out in the room in front of the speakers filling up the space between the listener and the transducers. The sound stage is almost spherical—not a curtain but a wide gelatinous bubble.

This is not a typical stable, focused, wall to wall, front to back sound stage with the people and instruments holographically fixed in space. This is a pleasure pool of pulsating plasma inviting you to dive right in with a colorful splash. And yet, for all its surrealism, there is something more correct and true to life about this kind of presentation than the cold and ridged, objective formality of the classical soundstage. This kind of emotional and esthetic involvement is more like what the mind does when it experiences live music.

This is not to say that SEDHT amplifiers don't make sonic holograms. A close miked soloist or vocalist is right there in the room with you as real as life. The sharp transient of a plucked string can be so startling as to make you jump. But these kinds of amplifiers reveal so much additional detail about the harmonic and micro dynamic structure of the music that the very notes seem surrounded by sheaths or envelopes of additional information, like the clouds of electrons surrounding an atomic nucleus. And this harmonic microstructure lingers long after the attack like a cloud of softly humming bees with the decay rippling on and on seemingly forever. And it is this kind of information which is being displayed holographically.

Sometimes the air just seems to fill with solidified sweetness—sweet, sticky cotton candy and interweaving ribbons of rainbow colored taffy like condensed sugar or shooting extrusions of candy striped, peppermint toothpaste. These are standing waves woven from the intricate, ever-changing moire patterns formed from intersecting fields of waves interacting with the senses, brain and mind. These are not only the sonic holography of the physical event but they also include the condensed forms of the emotional and esthetic aspect of the listening experience. These kinds of holograms are like luminous objects hanging suspended in space, spun not only out of the music but from one's reaction to it.

At other times the experience of Steve's amplifier is like being afloat in a vast ocean—the secret sea of SE triode owners. Here listening becomes swimming. Once merged with the sound you are no longer a fixed location in space, sitting on the sofa standing back in objective evaluation, but you become a perpetually self-transforming musical liquid that ebbs and flows, surges and pulses, swelling and drifting until you become an oceanic superfluid washing against the walls of the room in a hydrodynamic tide. You are swimming "with" the orchestra or more correctly, swimming "in" the orchestra.

This kind of listening takes one back to childhood. Long before the compact disk and the digital domain, before the iron footed Krell—before the yawning 45 recordings, before the endless dusty succession of components stretching back like a caravan of shadows—back to childhood. Laying on the sofa on a rainy afternoon, listening to K-Jazz or Public Radio in mono FM on an old Sylvania, not listening to the speaker or the electronics but dissolving in the music and being transported by it and healed, refreshed, nourished and restored.

This was where it began, the love of music, the first imprinting of the quest for primary musical experience. This was the primal cause of the endless succession of seeking better and better sound—upgrading and upgrading until eventually I lost it. The Goddess who had inspired, uplifted and transformed the heart had vanished into the brightening air like the momentary, transitory touch of an elusive Muse leaving only the echoing memory of perfection.

Now years later, so many thousands of dollars later, expelled long ago from the Garden of Eden—after all the agony and the ecstasy—the supreme gratification and eventual disappointment and ultimate disenchantment.

I want to go back. Back to when I and the music were one, back to the innocence and simplicity of pure, direct esthetic experience before stereo became a status symbol. I don't want to be proud of my music, I want to "be" my music. I want to stop listening to my stereo system. I want to get back to the sound.

SEDHT amplifiers are ecstasy producing machines. You don't just "listen" to them, you tune into them. These devices are somehow directly connected to the pleasure center of the brain. They must alter brain chemistry on some level. Dopamine and serotonin receptors might be involved here.

SEDHT amplifiers like Steve Berger's Multivalve 45s take me back—all the way back and beyond—to a musical satisfaction I thought I would never see again. And the future? I think I'll sell the Futtermans and have Steve build me a pair of his top of the line, no compromise SEDHT monoblocks. OTL 1s anyone?

A HIGH EFFICIENCY TRIODE AMPLIFIER

by
MELVIN C. SPRINKLE
Peerless Electrical Products Div.
Altec Lansing Corporation



Fig.1 Peerless amplifier which was available in either the kit (10722) or completely assembled form, back in 1949

The legion of audio enthusiasts who have stuck by their triode amplifiers through thick and thin have been a hardy lot. They have been assailed by the beam power camps and have been deserted by commercial amplifier engineers, but through it all have held the bridge like Horatius. Through all the controversy they have always maintained that "triodes sound better."

The Achilles' heel in their argument, however, has been the inefficiency of triodes. In spite of all the subjective arguments, the fact remained that up to the present time triode power was costly. In order to realize the full benefits of triodes, it was necessary to operate with fixed bias—this meant either a high voltage power supply with higher voltage condensers or a separate bias supply. Furthermore, because of the high bias required, transformer coupling into the final stage was necessary. Resistance coupled amplifier stages just don't put out high quality signals with enough amplitude to drive triodes. Both triode power supplies and/or transformer coupling are expensive.

On the theoretical side, triodes have had at least a strike and a half on them. Assuming proper power supply for plate and bias, and good transformers, Terman states that the maximum practical efficiency of a Class A amplifier is 50%, and that practical amplifiers have efficiencies from 33% down to 20%. This meant that in order to get an output of 10 watts delivered plate-to-plate—not necessarily in the load—it was necessary to put 28.6 watts into a pair of tubes, and if the efficiency was of the order of 20%, the input power had to be 50 watts. No wonder that triodes were limited to low output power! As a matter of fact the heads of many designers were scratched in the search for a high dissipation triode without going into the expensive transmitting tubes. The development of Class AB operation was a partial solution as the efficiencies were raised. Terman gives efficiencies of 40% to 50% for this operation, but the tube manual in its typical operation data for 2A3 tubes says that the efficiency is 34.1% when the tubes are operated with fixed bias.

Class AB operation of triodes has become accepted by audio enthusiasts who require high quality, but they have in general been very dubious about Class AB2. Up to the present time there has been some justification for their doubts. Recently, however, with the general availability of high quality transformers, operation of tubes up to, and possibly into, grid current becomes possible with no more distortion than strict Class A operation, and with a prodigious increase in efficiency.

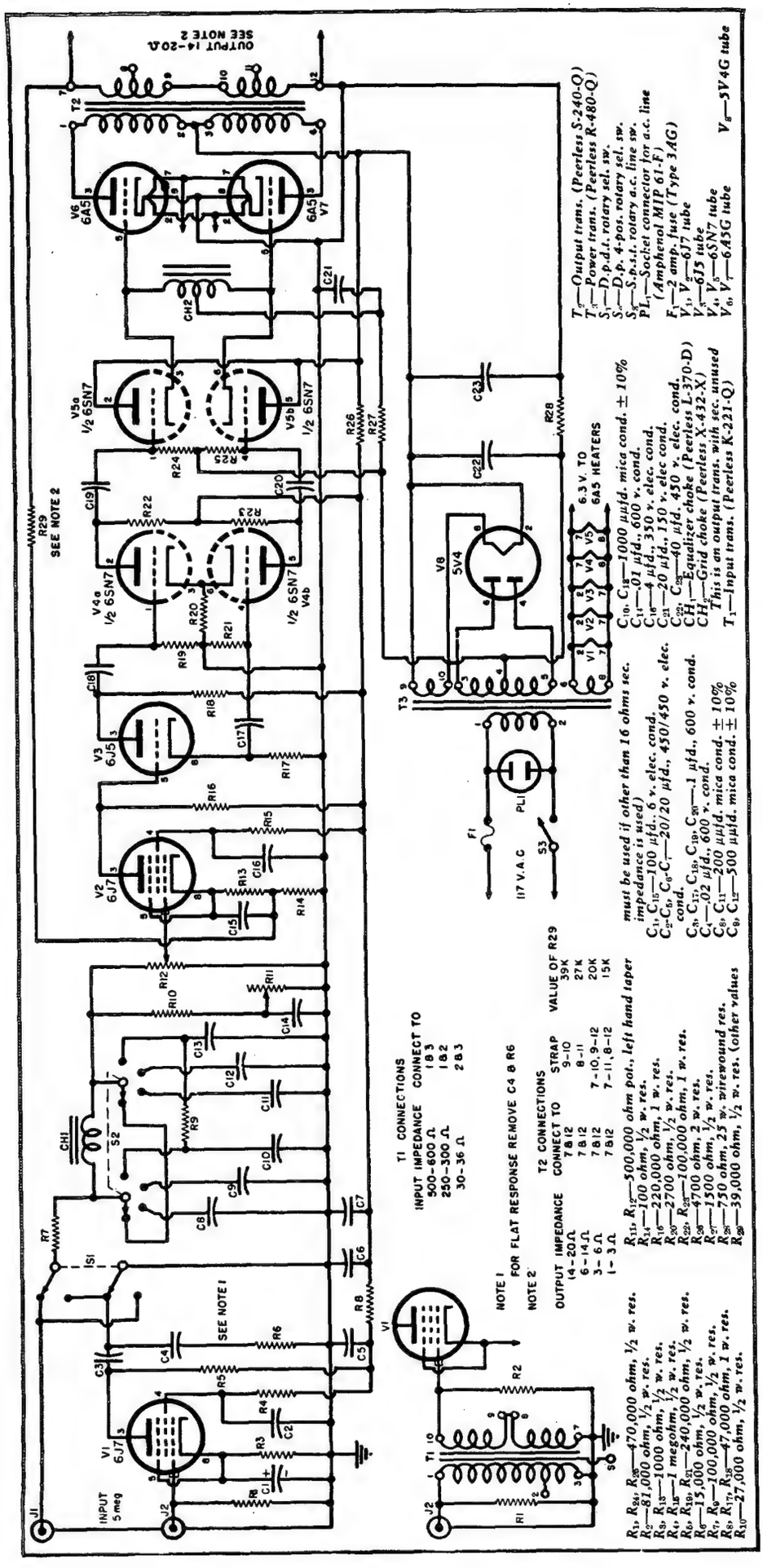
Recently, the writer has become interested in a circuit which makes possible 18.6 watts output from a pair of 6A5 tubes at a distortion of 5% total harmonics! This represents an efficiency of 49.3%, a truly remarkable achievement. This amazing performance is made possible by two factors: (1) A good output transformer and (2) Use of a cathode follower driver.

The output transformer is the heart of an amplifier. Almost invariably the output transformer is the only audio transformer used, the other stages, with the possible exception of an occasional input transformer, being resistance-capacity coupled. The techniques for building wide range resistance coupled stages are well known and easily put into practice. If the results are not satisfactory, the builder can easily change values until the desired results are obtained. However, when one buys a transformer, he must accept whatever the manufacturer puts into the unit. There are a few things that the user can do, but in general these have minor effects on overall performance. For example, one cannot alter external circuits to improve efficiency—the ratio between primary power and the power delivered to the load.

It behooves the constructor, therefore, to buy the best possible transformer, considering the following points:

a) Insertion loss. The useful power output of an amplifier is the power delivered to the load, not the power measured plate to plate on the primary side.

b) Power output over frequency extremes.



Vast numbers of amplifiers are built by audio enthusiasts who have absolutely no idea of how many watts their amplifiers deliver at 40 cycles and 10000 cycles. Their conception of performance is based upon frequency response, which is a gain measurement, not a power measurement. The factors which contribute to power output at frequency extremes are not controllable by the user.

c) Frequency response. The frequency response of a transformer is a measure of its ability to transmit various frequencies; i.e., it is inherently a gain measurement. As pointed out above, the power output characteristic is often a more important property in output transformers, and it bears no relationship to the frequency response characteristic. On frequency response, most manufacturers show response in the audible part of the spectrum, but what is more important is the response at frequencies above and below audibility. This response is of importance because in amplifiers employing inverse feedback, the response must be much broader than the range to be covered if the amplifier is to be stable.

d) Concomitant with frequency response is phase shift. This is of importance if complex signals are to be transmitted without distortion and also if stability with inverse feedback is to be achieved. Phase shift, frequency response, and transient oscillation are most easily checked with square waves.

Fig. 2 Diagram of the Peerless 10722 amplifier. Circuit includes a preamplifier for magnetic phono pickups. With the addition of a special input transformer (circuit shown in lower left) the amplifier becomes suitable for use with a 30, 250, or 500 ohm microphone or other low-impedance, low level source. The equalizing network can be removed when used with a microphone.

Notes on original circuit drawing:
5V4 is shown as a directly-heated rectifier when it is actually an indirectly heated type.

T1 is 700V@120 mA B+, Rectifier winding is 5V@ 3A per Peerless specs provided by Magnequest.

Schematic as originally published had the grid of V7 connected to the B+ line at C21, obvious error. Removed in this version.

Most audio enthusiasts are familiar with resistance or transformer coupling to Class A or AB amplifiers. These systems are quite satisfactory within certain limitations, but fail when Class AB2 operation is approached. The fundamental reason is that when the grid of a tube is driven positive, instaneously there is a flow of electrons to the grid, which when they flow through the grid resistor, or even an interstage transformer, produce a voltage which is additive to the tube's bias. The effect is the same as the bias developed in an oscillator's grid leak due to grid current. In the usual Class AB2 design, a special transformer called a driver transformer is used, which is a step-down transformer. In order to supply enough signal with a step-down turns ratio, and also to supply power to the grids of the final when they draw grid current, it has been necessary to use a power tube as a driver.

Another factor that touches a sore spot in constructors is the cost of a good driver transformer. The cathode follower driver overcomes these limitations. It has been pointed out that a cathode follower is not a voltage amplifier, i.e., the output voltage can approach but not exceed the input signal. However, and this is not as widely known, a cathode follower can be a power amplifier. The power in a resistor is given by the familiar formula P=E2/R thus for a constant voltage. The power varies inversely as the resistance. Halving the resistance gives a 3 dB power increase for the same voltage. Thus a cathode follower can take in say 25 volts and in its output develop this same voltage (almost) across a much lower load, and thus give a power gain. By simple circuit manipulation, a cathode follower driver stage can be direct coupled to a power amplifier. It is possible to obtain excellent frequency response by the direct coupling and yet supply all the normal DC voltages to both stages. A low grid circuit impedance for both AC and DC is provided and there is sufficient power developed in the cathode follower to take care of grid current demands should operation in this area occur. The combination of two equally important factors—a good output transformer and a cathode follower driver—produces a high-efficiency, high quality circuit that puts the triode on a more equal basis with beam power tubes.

This high-efficiency circuit has been incorporated into a general purpose amplifier, specifically designed for high quality music reproduction, called the Peerless A-100A amplifier.

With the development of this amplifier, the problem of low efficiency in triodes has been largely overcome. The unit has a maximum output of 20.3 watts. It uses two type 6A5 tubes in a newly developed circuit which makes practical efficiencies on the order of 49.3%. Moreover, and this is the crux of the matter, this power is useful secondary power, the implications of which were considered previously.

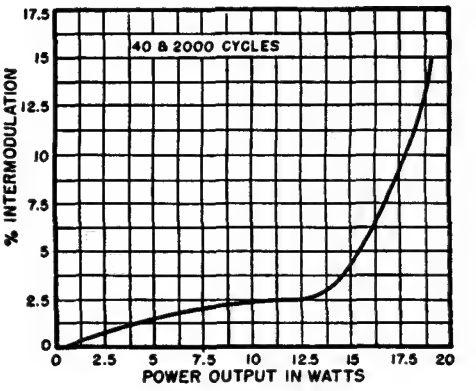


Fig. 3. Power output in watts vs. per-cent intermodulation distortion of amplifier.

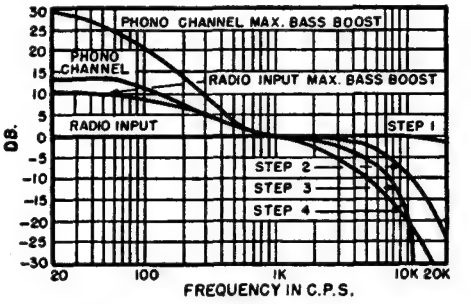


Fig. 4. Amplifier response with low-pass filter and bass-boost circuits operating.

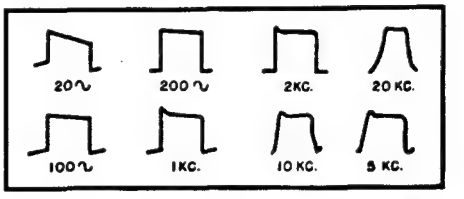


Fig. 5. Square wave patterns at various frequencies throughout amplifier range.

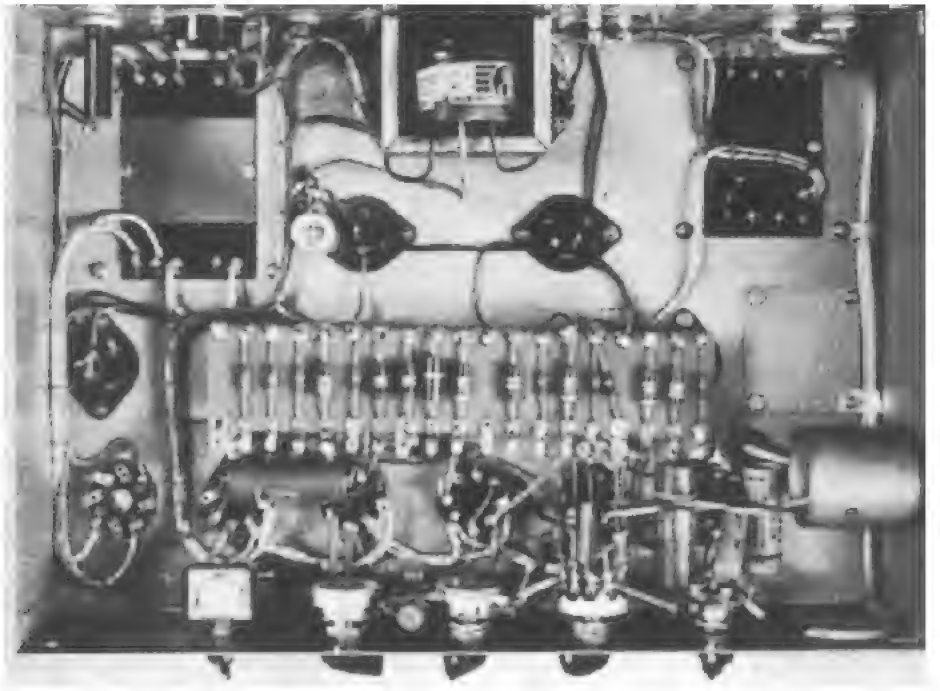


Fig. 6: Under-chassis view of the amplifier which was available as a commercial kit back in 1949

The frequency response of the amplifier is flat from 20 c.p.s. to 15,000 c.p.s and is down only 1/2 dB at 20,000 c.p.s.—an undetectable amount.

The distortion is remarkably low. Using the familiar 5% harmonic content standard, the power output is 18.6 watts at 100 c.p.s. and 400 c.p.s. At 40 c.p.s., the power output is 14.8 watts and at 5000 c.p.s., the power output is 18.3 watts. Using the intermodulation method with test frequencies of 40 and 2000 c.p.s., the power output at 8% intermodulation is 17 watts.

The schematic diagram is shown in Fig. 2, and it will be seen that the amplifier is entirely straightforward in design. The first stage uses a type 6J7 tube as a voltage

amplifier. This stage is used as a preamplifier for the magnetic phono pickups so popular in high quality music systems. The plate circuit contains a series resistor-condenser combination, the values of which are adjusted to give the bass boost required for proper equalization of magnetic pickups. A feature of the amplifier is a cutout provided for the installation of a Peerless K-221-Q input transformer. With the transformer installed, the amplifier becomes suitable for use with a 30, 250, or 500 ohm microphone or other low impedance source, the equalization network being removed when a microphone is used.

Two inputs are provided, one for phono and the other for radio. A switch, S1, selects the desired input and grounds the channel not in use to prevent crosstalk. In the phono channel, a gain of 107 dB at 100 cycles is available, which permits full power output from LP records. The radio channel has a gain of 84 dB, which is more than adequate for any FM or AM radio tuner.

Following the radio-phono switch is a four position, pi-type low-pass filter which is intended for record scratch reduction. The filter uses an inductance to give sharp cutoff so that the maximum useable recorded signal can be reproduced and the higher noise frequencies eliminated. The circuit must not be confused with resistor-condenser treble roll-off circuits and is quite different in performance. Four positions are provided, the characteristics of which are shown in Fig. 4.

In addition to the low-pass filter, there is provided a continuously variable bass boost circuit. A resistor-condenser network is used to provide up to 10 dB of bass boost as shown in Fig. 4. A word of caution might be in order at this time. The bass boost control must be used with discretion, since the transformers provide considerable power at low frequencies.

The second stage uses a type 6J7 tube (V1), pentode connected to give high gain and very low distortion. A small portion of the cathode resistor is not bypassed as this is used for inverse feedback. The third stage (V2) is a type 6J5 used in a split load or cathodyne phase inverter circuit. This type of circuit has several advantages among which are almost perfect balance in the output over wide frequency ranges, independence of changes in performance with tube replacement, inverse feedback for improving linearity, etc. In addition, the circuit lends itself readily to direct coupling from the preceding stage. The positive voltage from the preceding plate circuit is more than offset by the high bias voltage developed by the cathode resistor, so that both tubes operate properly. The direct coupling permits extension of the low frequency response to DC and eliminates coupling networks which can cause phase shift and low frequency attenuation. It will be noted in the schematic in Fig. 2 that in the "radio" channel only four coupling capacitors are used in the entire amplifier, two on each side of the push-pull system. As both of these are of generous capacity, and the frequency response of the output transformer specified is no more than 1/2 dB down at 20 c.p.s., the low frequency response is very good.

The phase inverter is resistance-capacity coupled to a type 6SN7 tube connected in push-pull. A fairly high load resistor is used in order to increase the voltage output and the cathode resistor is not bypassed to take advantage of inverse feedback action in balancing the push-pull system. The stage is resistance-capacity coupled to a type 6SN7 tube used as a cathode follower driver.

The cathode follower is direct-coupled to to the push-pull power amplifier through an ingenious circuit. Each cathode is directly connected to a power stage grid. The cathode current flows through each side of a center-tapped choke, which has low DC resistance so that no DC biasing voltages are developed. The choke has sufficient inductance so that its inductive reactance, which is the cathode follower load, is high, even at 20 cycles. The cathode currents from both sections of the cathode follower flow through R27 which develops the bias voltage for V5 and the negative end of R28, which is between the power transformer high-voltage center tap and ground, providing fixed bias for the power stage.

The power amplifier consists of a pair of 6A5 tubes coupled to the loudspeaker through the output transformer, T2. As the tubes are operated with the fixed bias, the cathodes are grounded. The 6A5 is very similar to the 2A3 and 6B4 in characteristics and application, but is equipped with a cathode which is internally connected to the center point of the heater. The heater-cathode construction results in a considerably reduced hum level over the directly-heated tube types and, in addition, the internal connection provides a center tap ground for the heaters. No balancing arrangement for DC plate currents in the output tubes was provided because the unique circuit and the latitude possible in the output transformer made it unnecessary.

It will be noted that inverse feedback is included in the amplifier. Inverse feedback is usually thought of as being used with beam power amplifiers, but the circuit is not confined to beam tubes. The benefits of inverse feedback are just as real with triodes. Approximately 7 dB of feedback is used, the feedback loop including five stages and the output transformer. More than this amount of feedback could have been used, but it was found that this amount produced optimum results. It should be pointed out that the value of the feedback resistor, R29, must be changed should the output transformer be strapped for other secondary impedances.

When the output transformer is strapped for a 16 ohm load, the internal impedance looking back into the winding, is approximately 2 ohms. Thus the damping factor, the ratio of load impedance to internal impedance, is 8 and thus the amplifier will adequately damp a high efficiency loudspeaker.

The power supply is conventional, using two high capacity filter condensers and a resistor to provide hum-free power. The resistor is used in the negative lead to provide at the same time, grid bias for the power amplifier. The type 5V4 rectifier was used as it has a low internal resistance resulting in an increased DC plate supply voltage.

Another effect of primary concern to the user is hum. Assuming that the high-voltage winding is properly center-tapped, hum can be produced by the stray magnetic fields from the power transformer. In some shell designs, using a single coil, the stray magnetic field may extend to audio transformers as far as three of four feet away, producing a hum that all the power supply filtering in the world will not eliminate. While the power transformer used in the A-100A Amplifier is of the shell type construction, it does have interesting features. The core operates normally at a flux density of 10,500 gauss and the cross sectional area of the core is uniform. The exception of course is at the joints, where only one-half of the core in continuous. It is the concentration of flux at these points which contributes so greatly to the large external field normally encountered in transformers of this type. Here though, the

interleaving of the laminations is in a 2x2 arrangement so that the transverse flux path resistance is increased to the same order as that of the air gap between the single layer E and I pieces.

While this arrangement reduces to some extent the structure permiability and increased the reactive exciting current, it also produces a more uniform flux distribution in the core, particularly at the joints. The reduction of flux "hot spots" reduces the external field. It also reduces the in-phase exciting current by an amount greater than the increase in reactive exciting current.

Therefore, two advantages result: (1) The external field is more uniform and less intense and (2) over-all I squared R losses (in both core and copper) are reduced.

The completed amplifier performs exceptionally well when tested with square waves, the square waves showing at a glance the frequency response, phase distortion, and transient response. Fig. 5 shows traces of square waves passed through the entire amplifier. At 20 cycles, the square wave shows some linear tilt which is caused by a slight phase shift. This tilt must not be confused with the exponential decay caused by lack of primary inductance often observed in inferior output transformers. The good high frequency response is confirmed by the fine square waves at fundamental frequencies at up to 20,000 cycles. There is no transient oscillation and only a little phase shift up to almost astronomical frequencies, as the square wave covers frequency and phase characteristics up to at least 20 times the fundamental. Square wave testing is becoming increasingly important as the performance of audio equipment is continually improved and has been widely publicized in connection with output transformer performance.



Whuppin' BUTT with TRIODES

by Joe Roberts

Something I've been meaning to do for a long time...

I'm a big advocate of the motto "Power ain't nuthin' but a number"—a slogan that I use to give credit to low power amps. By now, however, most of us already know that a fine low power job on Altec horns or a similar sensitive loudspeaker can sound absurdly powerful in terms of subjective music playing capability, so where's the news in that?

I hate to let a classic slogan die just because it has outlived its social usefulness as a single-ended propaganda measure. Well, what about the other side of the coin, the implication that higher power amps can provide good listening too? Although the suggestion seems to be hovering around in some triode purist circles, would anybody go so far as to come out and say that an amp above ten watts automatically sucks? Of course not!

While modern experimenters have made vast progress appropriating the single triode paradigm and taking it almost everywhere it is possible to go, most alternative hi-power approaches, especially parallel and push pull triode amps, are relatively underexplored to date, an untapped world of new sounds.

Back in the 80s, before I built my first SE amp, I thought PP triodes were the last word in hi-fi, just as they believed in 1949. I used to trade schematics and vintage gear impressions with tubehead super-freaks like Larry Rubins up in Jersey and Andy Bouwman (now of Vintage Tube Services) who were on the same track. Old-style homebrew PP triode amps were blowing our minds. I think I forgot how great that stuff really was.

There weren't many vintage consumer pieces that used triodes (or triode-wired beam tubes). The Brook amps, the Fisher 50A, and Bell 2145, all high-dollar products from around 1950, each had trick iron-core driver stages to waffle the power tubes into Class AB for maximum output. In other words, the expensive triode amps were high-power amps for the time. These days, in contrast, the price seems to go up as the output power goes down!

I'll get into the circuits of these 1950-era high-efficiency PP amps in part II of this article, but I found the Peerless amp design reprinted above to be an interesting distillation of high-power professional amp concepts for home hi-fi use. The topology is sort of a baby Altec 1570 circuit, with 1/10th of the power of the big Class B 811A drive in movie theater amps The overall A-100A design and Sprinkle's presentation of it have a classic pro-sound engineering vibe to it that I find reassuring, even though simpler approaches are much more fashionable in the late 90s.

The whole "high-efficiency amplifier" premise of Sprinkle's essay strikes me as an artifact of the professional engineer mindset of the day. Sprinkle treats *Efficiency* in itself as a greatly desirable quality, although he never proposes *why* it is so desirable or what to do with the extra power per kilowatt hour gained. One would think that most hi-fi nuts who would build this circuit, then or now, wouldn't worry too much about spinning the electric meter a few extra revolutions to enjoy the sound of a fine Class A triode amp. Given the choice, who among us wouldn't gladly pay a few additional bucks on the utility bill for sonic enhancement?

Well, I know what I'm going to do with the high-efficiency output power of the Peerless amp. I don't really need all that juice on my horn system but I sure like the idea of a beefed-up PP 2A3 for full range use. And I like the idea of the potent driver stage that Sprinkle discusses, even if I don't need the full output of the amp. If eighteen full watts ever goes up the speaker wire towards my TAD 2001 driver, I don't want to be in the room when it happens! Remember the formerly-popular concept of having substantial power overhead so the amp coasts along at normal levels? Well, I guess it can't hurt.

Part of what I wanted to get back into by building the A-100A circuit is to get back into that classic old timey approach that I used to love so much. A lot of the experimental work in progress these days is so high-tech, slick and sleek, using the most advanced tubes and smart purist/minimalist schemes, that I felt like building an "out-

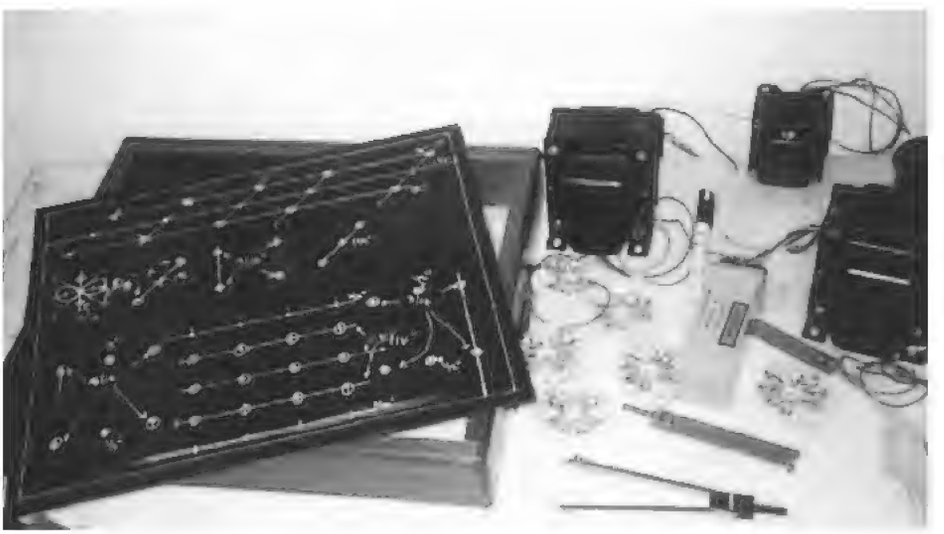


Alright, Homey, here's the damn race car pic, now where's the iron, sucker?

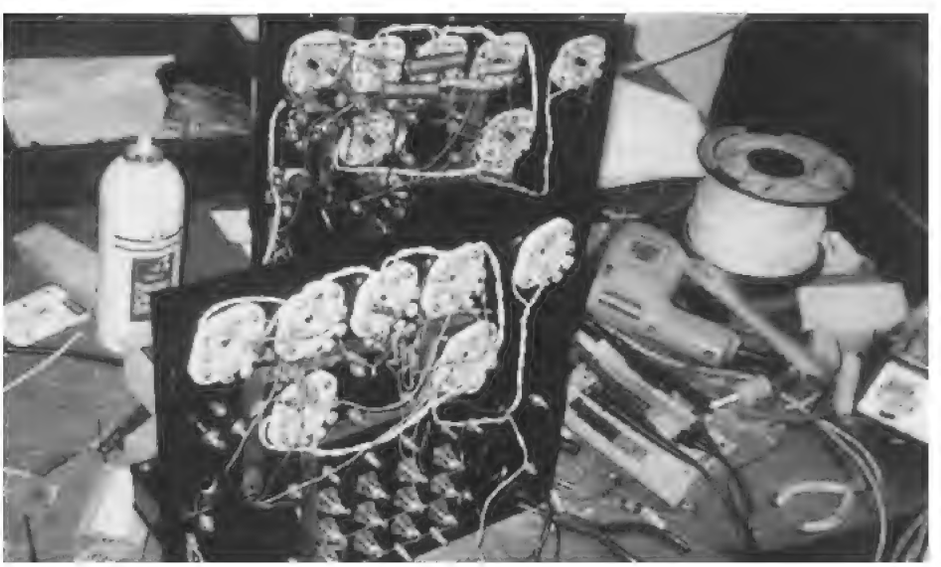
moded" amp using good old WWII tubes like top-cap 6J7s and 6SN7s. I know this uncool old school scheme can still really play music in a very satisfying manner.

Well, it sure ain't a minimalist gem. I chopped off the preamp stage and still needed seven tube sockets per amp. Yet, I can relate to why each stage is there, the reason behind the elaboration. Here's what good solid audio engineering used to look like. Those old-timers weren't afraid of an extra tube or two if they needed it. Sure, I was tempted to "update" the circuit, but then I chose to stick to the original plan and see where it goes—for starters, at least.

The ploy worked: A heavy box of iron from Philly arrived at my door and I was quickly off to the workshop.



Soldering iron in a heated condition. Peerless amps edging toward completion.



The first step in building an amp is deciding to build. The second is procuring the transformers. I called Mike LaFevre of MagneQuest, custodian of the Peerless tradition, to see what it would take to scam a set of iron for these amps.

Ho, ho...no small task. As anyone who reads rec.audio.tubes knows, LaFevre is no easy shake-down target. First, I told him "Mike, when I write up this amp you'll sell so many transformer sets that you won't have to work for five years." He didn't go for that flat-out lie. I tried appealing to his love of Peerless and his sense of pride toward these fine US made iron-core components, which he now makes. That shameless pandering didn't work either. Finally, I unleashed my heaviest psy-ops tactic. I promised Mike that I would print a photo of the nifty Creamsicle-orange MagneQuest-sponsored sprint car if he could arrange the long-term loan (30 years) of a pair of S-245Q and a couple power trannys, and it wouldn't hurt to throw in some split chokes for the drivers also.

Well, finally we get cooperation. It turned out that he had some 245s wound leftover from a Japanese order sitting in his basement and the mofo was just holding out on me! Anyway, I had the OPTs and two freshly-wound powers and audio chokes (still smelling like the hot wax the coils were dipped in) at my door in a week. Of course, the race car pic was also in the box. A deal's a deal... Gentlemen, start your engines!

(To be continued)

ISSUE 17 ARTICLES

Homebrewer of the Month: Joseph Esmilla

3 Phase Power Thomas Mayer

The Legacy of Thorens TD-Series Turntables Stefano Pasini

Thorens Pt.II Stefano Pasini

KLANGFILM: Postwar Cinema Amplifiers Heiner Jakobi

Whuppin' Butt with Triodes: Round 2 Joe Roberts

Darling Fest '99!!! Jeremy Epstein

A Homebrew Horn for Tannoy Dual Concentric Loudspeakers Roy Hilsley

Second Order Harmonic Cancellation in the SE Amplifier: Is it a sound practice? Ivan L. Johnston

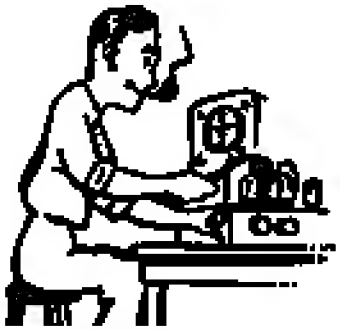
Caligula Incarnate: PPP 6080s! Jim Carlyle

Surrounded by Tube Sound Jim Fosgate

Adapting a Transistor Curve Tracer for Tubes Alan Douglas

SRPP POWER Flemming Madsen

Not Your Father's Dyna Mod: Retrofitting the Push-Pull Classic for SE Triodes Ross Lalhum



Homebrewer of the Month

Joseph Esmilla of Suburban Maryland

Simple circuits and quality parts yield top musical satisfaction

Enclosed are pictures of my present system which has evolved over the past six years inspired by reading Sound Practices as well as Japanese publications like MJ and Stereo Sound. My circuits are pretty straightforward and conventional, nothing radical or innovative. I am a violinist not an electronic engineer... I just paid close attention to using tubes that I am familiar with sonically, preferring Art Deco era preamp, input, and driver triodes for voltage amp applications in a given circuit topology based on years of listening and experimentation.

I used parts that sound good to my ears. Carbon resistors (Allen-Bradley, Riken, or carbon film types from MCM) for plate load and cathode bias. Paper in oil or copper foil caps by Jensen, Icar or Facon for coupling. Cerafine, LCR or Solen caps for PS filtration, Black Gates for cathode by-pass and Kimber TCSS or AGSS for wiring in the signal path. Lately I've gotten good results using 19 gauge solid core 99.99% silver wire with Teflon sleeving, much more affordable than AGSS.

I did all the metal work using Greenlee chassis punches with lots of WD40 to cut through 1/8" thick aluminum plates. Except for the custom maple wood bases on the 300B monoblocks, the rest of the woodwork was also done by me using pre-cut lumber and a $10 miter saw box from Sears.

I am not much of a writer but I will try to describe the pictures and throw in a few comments.

My phono front end is a Garrard 301 "grease bearing" mounted on a homemade plinth using 7 layers of 3/4" thick, 22 x 20" birch ply. I used the 301 template to cut out the first 3 layers to accommodate the turntable assembly, the remaining 4 layers are solid except for tonearm mounting provisions. After all the necessary holes were cut,I used animal glue (used by violin makers) which is very thin in consistency and does not settle quickly so that I could align every layer before clamping them to dry overnight.

For tonearms I use a Fidelity Research FR64fx and an Audio-TechnicaATP12T. My cartridges are an Ortofon SPU Classic GME and a Denon 103R in an Orsonic headshell. Both cartridges are fed through Mogami microphone cables to Tamura TKS 83 MC step-up transformers.

The SPU GTE is a very musical cartridge, very lush and delicate sounding. I listen to it to enjoy music by candlelight while sipping a glass of cognac. On some recordings, it can sound rather veiled and this is when I switch over to the 103R which is perfect for playing recordings that sound rather "slow" since it is an "accurate" sounding cartridge.

The FR64 and SPU are gifts from buddies in Manila who formed a club called SETUP (Single-Ended Triode Users of the Philippines) whom I have influenced to dabble with DIY and subscribe to Sound Practices because of their frustration with "high-end."

Initially, I thought I cured the 'impulse' upgrade syndrome (from WATT/Puppies to GRAND SLAMMS, SME V to Air-Tangent, etc.) that plagued my buddies—however, now that they've seen the light, I am constantly bombarded and hounded by e-mails discussing the merits of Amorphous core F5002, Permalloy NY15s, 10429s and Kanno OPTs. They've even built a transformer-coupled line level preamp using Tango NP216N iron. I'm sure this keeps Yokota-san of Sound Shop Big busy and happy, but I'm afraid their wives and girlfriends might not talk to me the next time I visit Manila!

My phono stage is based on the RCA tube manual phono circuit, using 5691s and battery bias. The line-stage is similar to the Berman featured in SP #15, with a 76 DC coupled to a 6SN7 cathode follower. I bypassed the cathode resistor on the 76 with a 100uf/10V cap since this gave a warmer and airier sound. To minimize microphonics on the 76s, I mounted the 5-pin sockets on rubber isolation spacers I found in a local hardware store that look very similar to those used in the Marantz 7.

The outboard power supply (barely visible in the picture below beside the left 300B monoblock) is a choke input type using a 5AR4/GZ34 rectifier producing about



Joseph and his DIY audio system in his 12 x 15 x 7.5' listening room



Globe 245 amp: Circuit is an SRPP 5691 with 2.2k,1W AB resistors,Facon .22uf paper in oil, 245 and a Tamura F475,5k OPTs. Kimber TCSS wire throughout.

275V for the line-stage and around 250V for the phono stage and a rectified DC filament line.

I only like SRPP with hi mu, lo gm tubes, finding the 6SL7/5691 best for the job. I tried SRPP 5687 and 6SN7 and understand why other people don't like SRPP.

I use AC filament supplies on all my power amps. In spite of the lower noise floor afforded by DC heated filaments on DHTs, I cannot find myself liking the "leaner"tonal balance.

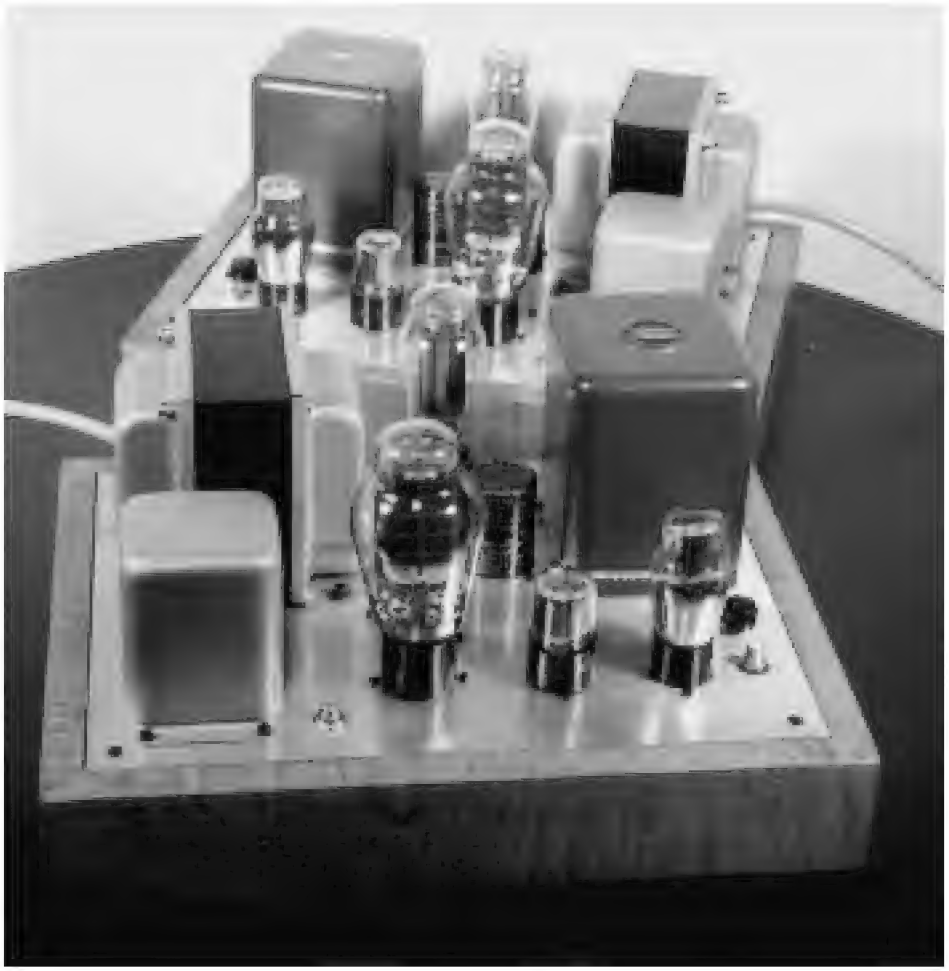
At the moment, I have five SE DHT amps at my disposal, this includes a Stereo 245 with Tamura F475s, Stereo 10/VT25A/801A with Tango FW20-7S, Stereo 300B with XE60-3.5s, a pair of monoblock 300Bs with Tamura F7002s and a Stereo 2A3 with U808s hooked to my TV/VCR hi-fi set-up in the bedroom driving "cheap 'n cheerful" (11 bucks a pop from MCM or Parts Express) paper coned 4 1/2" Pioneer full-range units in a homemade TQWT cabinet.

Except for the 245 amp, all my power amps share the same basic input/driver topology - DC coupled two stage circuit using low-to-medium mu triodes. My first attempt in building an SE amp used both sections of a 6SN7. I tried RC coupling between stages but prefer the added texture and dynamic nuances afforded by DC coupling.

Later on, I investigated using 56, 76 and 27 since they are claimed to possess greater linearity than the 6SN7. After several prototypes and listening sessions I kept the 6SN7GTB at the driver stage preceded by a 76 or 56. Using a 76 as a driver tube just does not cut it for me; it sounds too lean. I also found that I like the airiness and warmth afforded by operating the driver tube around 6 or 7ma.At close to max. current (~10ma.), the sound becomes dry and analytical for my taste. For the input stage I shoot for about 3 or 4 ma. of current.

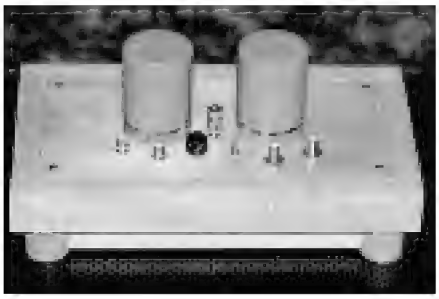
My latest 300B monoblocks use Cunningham 327 "mesh plates" (pulled out of an old Atwater-Kent radio I found at a flea market) at the input stage, DC coupled to 1/2 6SN7GTB. This combination is very transparent across the frequency band— less midbass crud and better definition, an almost 245 or WE205D-like vividness in the mids with delicacy and airiness in the highs!

The WE300B re-issues are indeed better than any version of the Chinese clones, but to me, the mesh-plate 327 probably contributed more improvement. I am talking about subtle differences here and the best way to describe it is that, once I take away the 327/WE300B combo, I know I'll miss



300B monoblocks: Circuit is a 76-DC-1/2 6SN7GTB-RC-300B-Tamura F7002, 3.5k permalloy OPTs. CLCLC power supply with a GZ37 rectifier and Cerafine caps. When he finds the time, he wants to try Cunningham "mesh plate" 327s pulled out of an old radio in place of the 76s.





ABOVE: Tamura TKS83 MC step-up transformers feature selectable impedance between 3 and 40 ohms and a provision for switching two inputs.

LEFT : Garrard 301 (early version) in a base made from laminated sheets of plywood

not having them!

Both the 10 and 245 amps possess a degree of refinement and finesse I could never quite capture with 2A3s (yes, even monoplates!) or 300Bs. I use the 245 amp mostly for solo vocals accompanied by a small ensemble or piano and the 10 for jazz quartet or trio instrumental combinations. Both amps are excellent for string quartets and my choice is really dependent on my mood.

Found some Globe 280s over the summer and changed the rectifier from 5U4Gs—didn't hear a difference in sound, but looks much nicer.

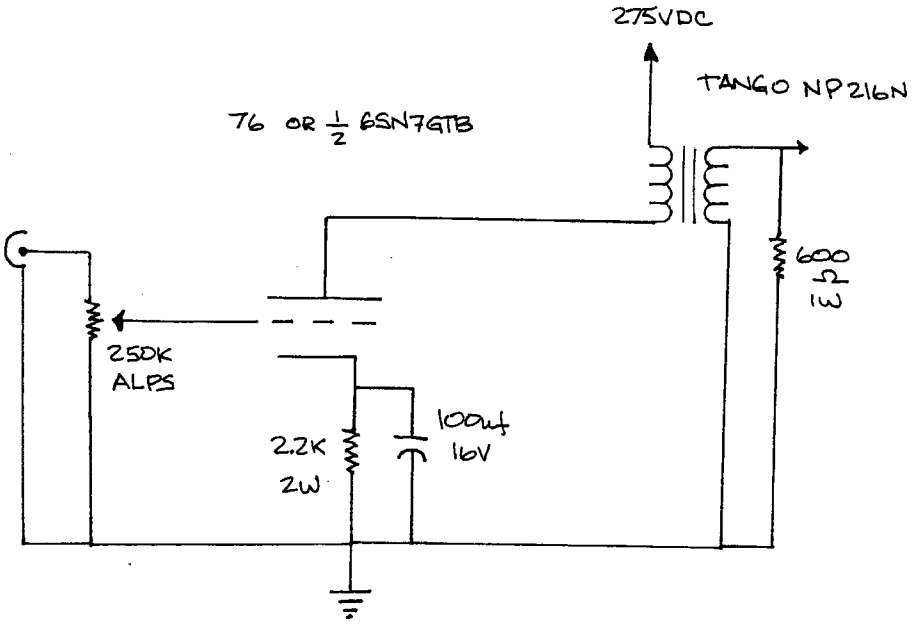
VT25/10 amp - 76-RC-76-RC-10/VT25-Tango FW20-7S. CLC PS using a 5R4GY rectifier.

Stereo SE 300B/2A3 amp using the same front-end and a similar CLC type power supply as the 300B monoblocks, but with Tango XE60-3.5s. Presently configured for SE300B operation, so that I can compare the sound of permalloy over regular "cut core"—my ears tell me that permalloy does have the edge in terms of midrange transparency but this is only obvious upon direct comparison.

Lately though, I'm realizing that there are Tango and Tamura "signature sounds", the Tango tending to be leaner and analytical whereas the Tamura is "juicier." Regardless of core material, both brands produce high quality sound and I would not want to open another debate as to which is better, but my taste tends to favor the Tamura.

For the past two weeks I've been listening and testing a pair of WE205Ds that are en route to Manila for my friends in SETUP. Since my power transformer (the Angela Universal) has dual HV secondaries, I soldered the 640VCT winding, changed the cathode bias resistor to a 1k, 20W and then "mismatched"the secondaries by using the 4 ohm tap to reflect a pri. Z of 7k when loaded with an 8 ohm nominally rated speaker. Actually, with 755As, it defeats the purpose since they are 4 ohms. Over the weekend I was over at my friend's house in NYC and we listened to it through his 8 ohm 604-8Gs. Using either speakers, the sound of the WE205Ds has the midrange quality of a 245 with the dynamics and slam of WE300Bs. They also go much louder than the 1.5W I measured—very nice!!!

My main speakers are Altec 755As on open baffles. I based this contraption on plans published in Stereo Sound "special issue"Vol. 3, 1996.The original plan called for a composite wooden material that is similar to



TRANFORMER COUPLED LINE STAGE USED/DEVELOPED BY MY "BUDDIES" IN "SETUP".

that used for chopping boards, but thinner, roughly 3/4". Since 3/4" birch ply is relatively inexpensive, I converted the dimensions to inches and found these baffles to work really well. For almost a year I've been using a pair of 755Cs until recently, when I found a nice pair of Altec 755As.

A friend gave me 2 cu. ft. boxes, considered by many to be de rigeur for 755As, for comparison. After living with them for a few weeks, however, I still prefer the open-baffle for either 755A or 755Cs.

755Cs go about half an octave lower in the bass with less high-frequency extension compared to the 755A—could this be psycho-acoustic? In the midrange, the 755A wins, no contest. To me, however, the 755C is still a sonic bargain since it probably does 85-90% of what the 755A can in the midrange, that's why I'm keeping mine as a spare.

The sound is very reminiscent of original Quads I had ten years ago. In terms of usable frequency range, they are equals. Just like Quads, there are no "boxy" colorations, an open and airy sound typical of dipoles, very life-like midrange, BUT much better rendition of dynamic contrasts and musical nuances when driven by single-ended DHT amps.

With a 300B or 2A3 amp, I can listen to Mahler symphonies on this system in my average sized room. The 10/VT25 and 45/245 being more suitable for the rather intimate setting of chamber music. Setting them up can be fiddly depending on your room. I used the same basic principles in finding the best placement for Quad ESLs.

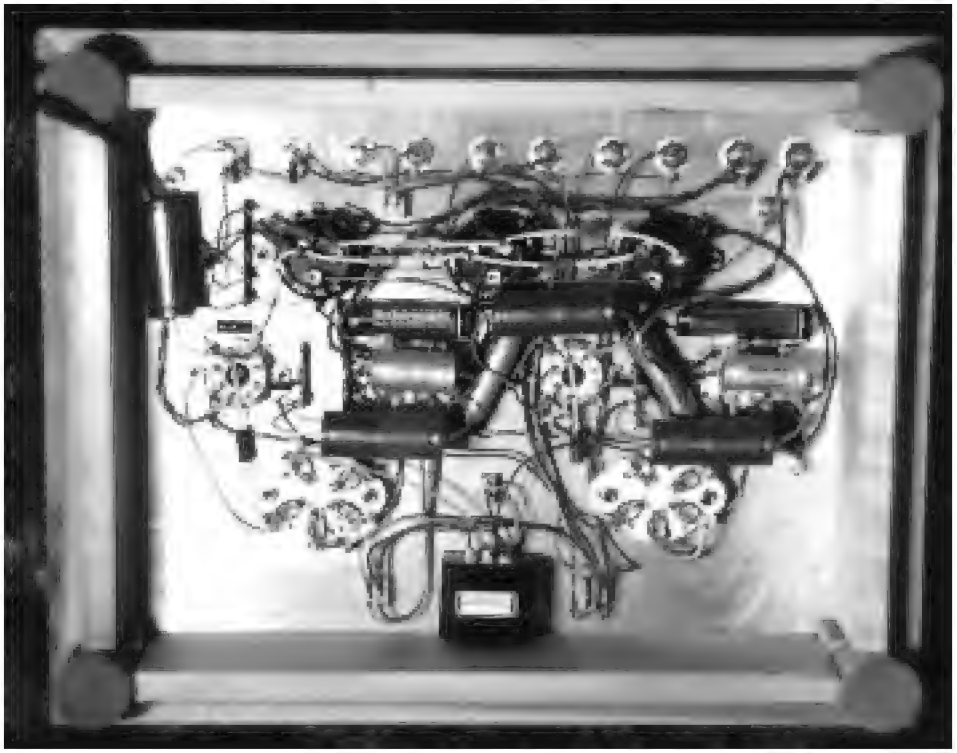
I've shared this open-baffle plan with a couple of friends who were startled to find such a simple device to work so well. In fact, my friend Ding in NYC mounted a pair of 604-8Gs to enjoy his SE45 amp.

I hope others will give this setup a try. I spent about $75 for 3/4" thick birch plywood cut to size and shape by a local lumber yard and about a half day's work putting it all together.

Other candidates for drivers I tried and heard include Altec 403A, 409B, Stephens FR80, Norelco 9710M and Diatone PM610Bs. Here's a summary of my initial impressions:

Diatone PM610Bs - I'm sure quite a few readers are familiar with these drivers. I acquired these in the original bass reflex box and didn't really like it too much, so I kept the drivers. The cabinet is overly resonant — colored mids, and boomy bass.

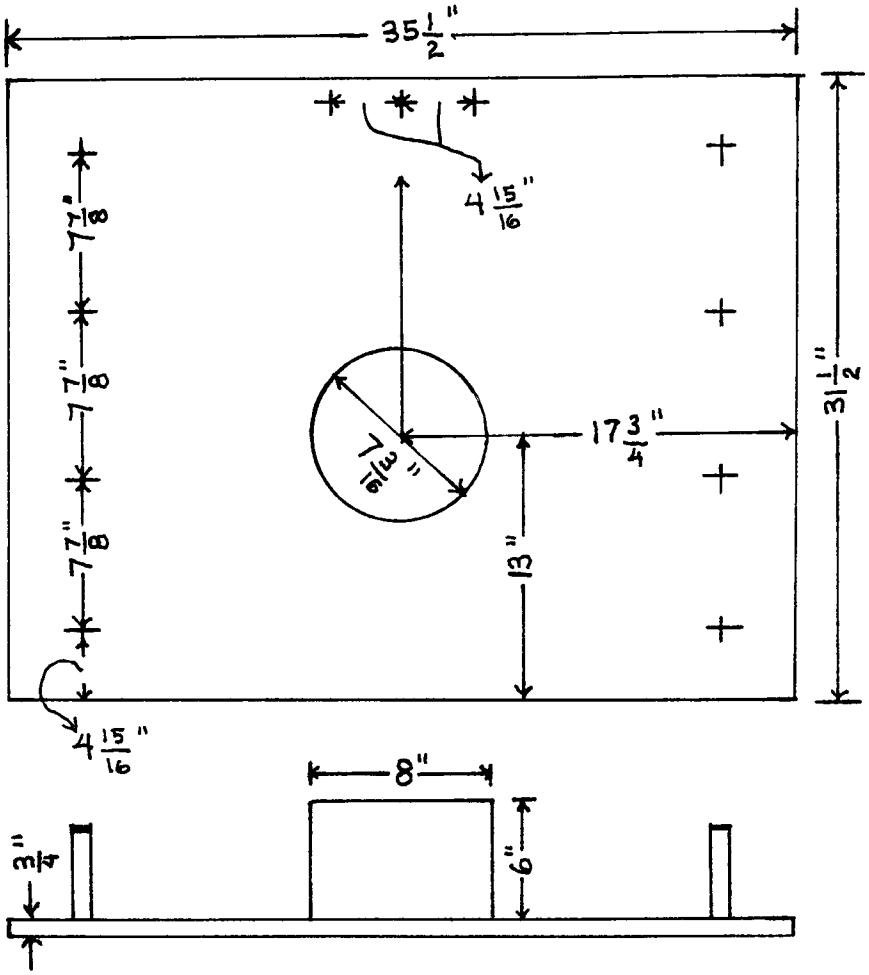


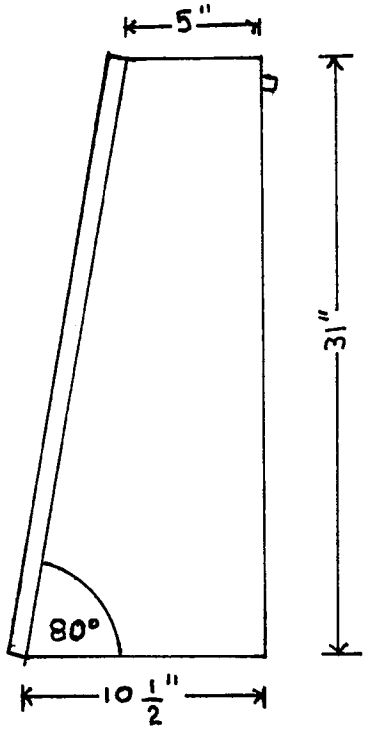


However on the open baffle, it started to sing. The midrange was warm and lucid but did not sound as "big" as the others in this group (smaller cone diameter???) and the tendency for the bass to boom was still slightly evident (too much compliance in the suspension??). Best performance with this driver is probably realized in a well braced bass-reflex cabinet or TQWT (quarter-wave pipe).

Stephens FR80 - The useable frequency range seem at par with a 755A, smooth and refined. However I found the sound rather dry and "closed-in", as if it cannot quite open up and boogie.

Altec 409B - Very efficient but also very dark sound, it surprised me that in spite of





the co-ax design, it had the least amount of treble output from this group. Maybe it will appeal to those who like BASS...or perhaps, I just had a pair of duds!

Altec 403A - this is a pretty decent sounding unit but unfortunately I only have one unit and had to listen in mono. The treble sounds more extended compared to a 755C. As nice as the tonal balance actually was, the midrange did not possess the "snap" of either 755s.

Norelco 9710M - Found this single NOS driver at a radio swapmeet over the summer. Again I had to listen to this in mono. There seem to be a lot of potential with this driver. It gives a totally different presentation compared to a 755A; with more bite and snap. Very dynamic and involving, however it can be argued that it is not as refined. Anyone willing to help me find a mate to this one?

Although I listen primarily to LPs, other sources include a Tascam DAP1 DAT player which I use for recording live performances (recitals and chamber music) with Shure SM81 mics, Sony TCD5M and Marantz PMD430 portable cassette decks, a Tandberg 3500X reel to reel, Scott LT110B FM tuner and a Philips CD921 with a DITB. Except for phono, cables are Kimber KCAG, PBJ and 4TC.

After several years of being involved in this hobby, I have determined that there is no such thing as the best component.A satisfying audio system entirely depends on synergy and voicing, best learned through DIY.

I like to view audio components in a similar manner as violins are evaluated by professionals. Guarneri del Gesus and Stradivariuses are established workhorses for world-class caliber violin virtuosos. Heifetz used a del Gesu throughout almost his entire career, whereas Milstein and

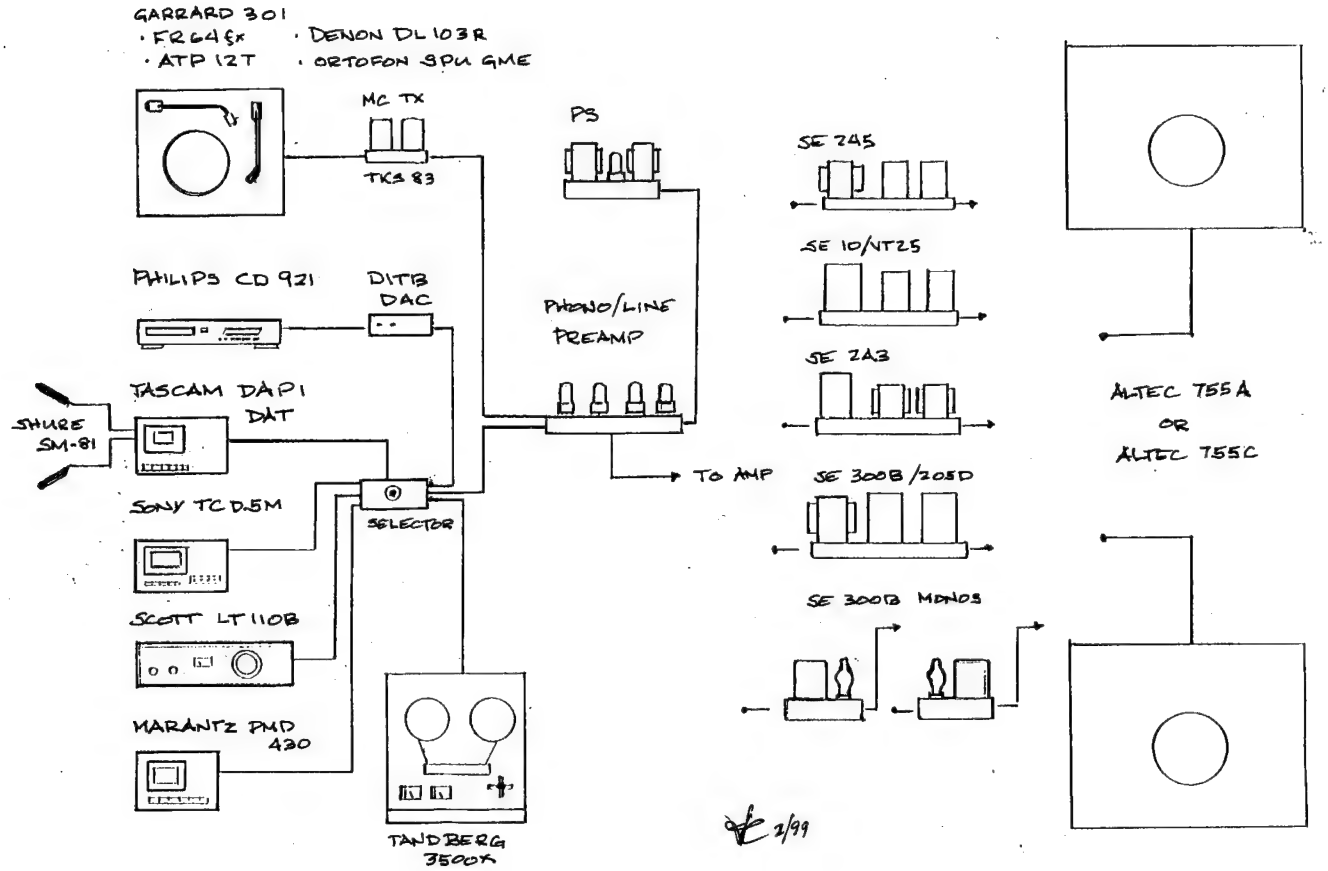
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Building tips for the Open Baffle:

1.I used No. 8 - 2 1/2" "decking" screws to put the whole thing together.

2. Make sure you drill pilot holes for mounting the 'feet' and the top plate (clamps help make this task more convenient).Those 3/4" birch plys are tough!

Even with pilot holes,I had to give my hand-held electric drill a rest every now and then during assembly to prevent it from overheating.



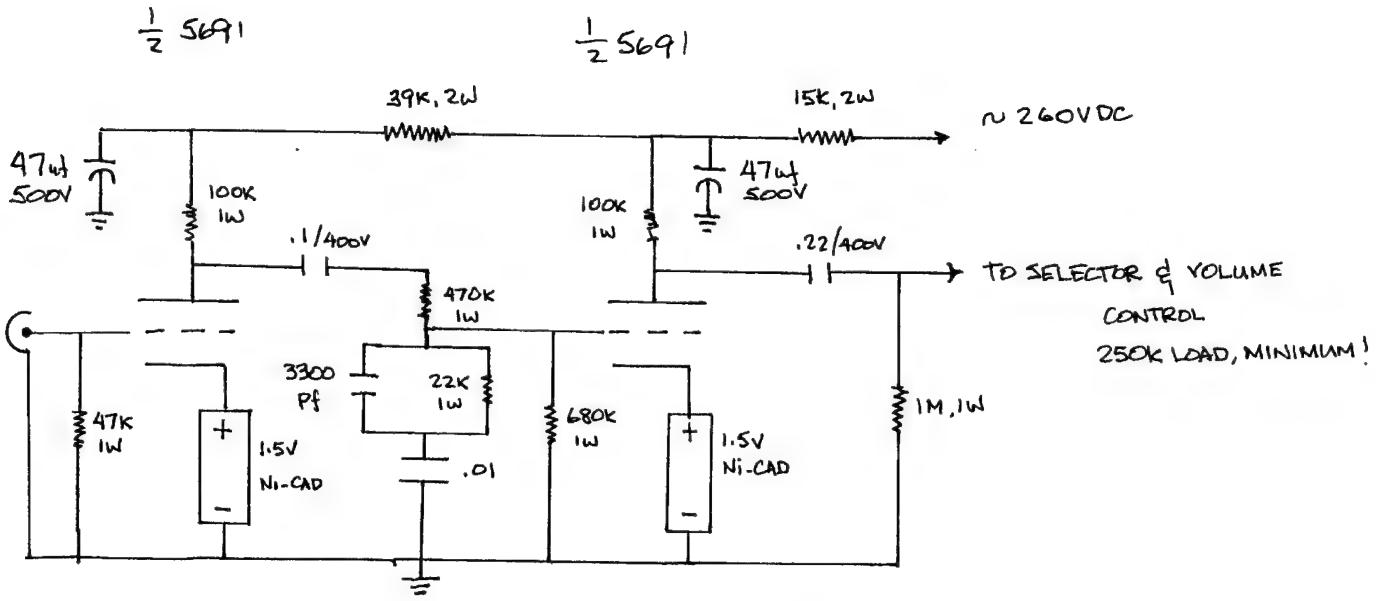


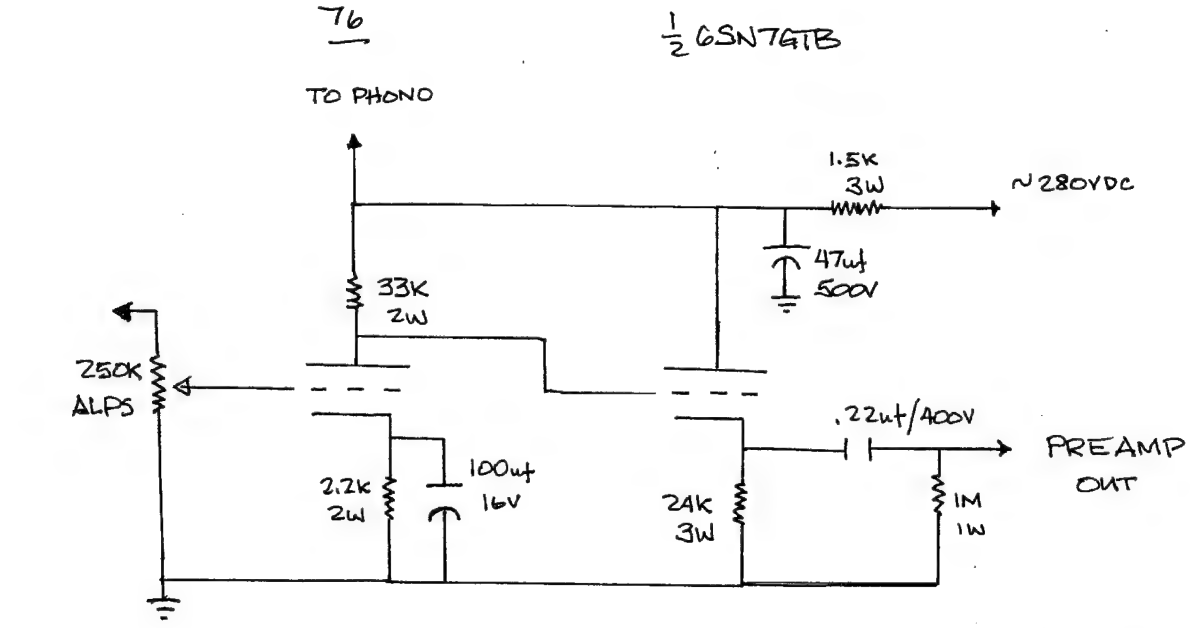
Oistrakh played on Strads. Kreisler played on both, as well as lesser known 18th and 19th century Italian, French and English violins.

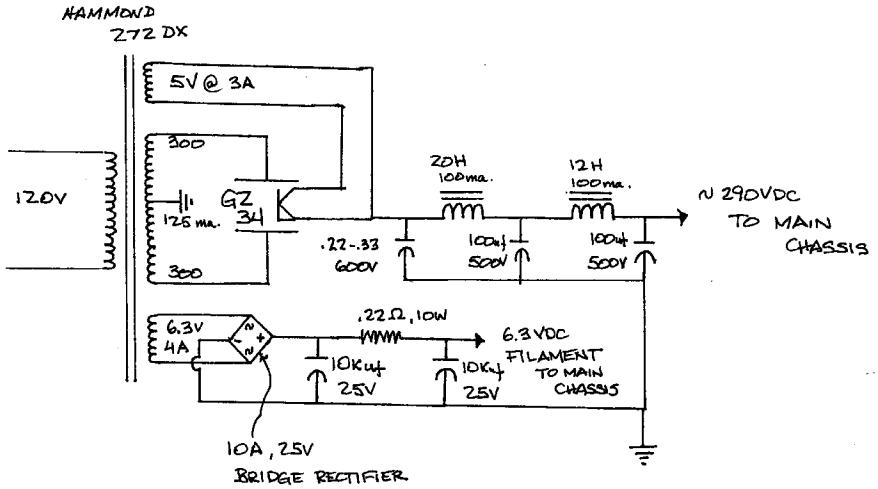
There is no objective process to evaluate a violin. No two Strads nor two del Gesu sound exactly the same, plus the fact that a particular violin will sound different in the hands of different players.

The bottom line is, these great violinists treated their instruments as tools and chose the best compromise to allow their artistry to unfold.

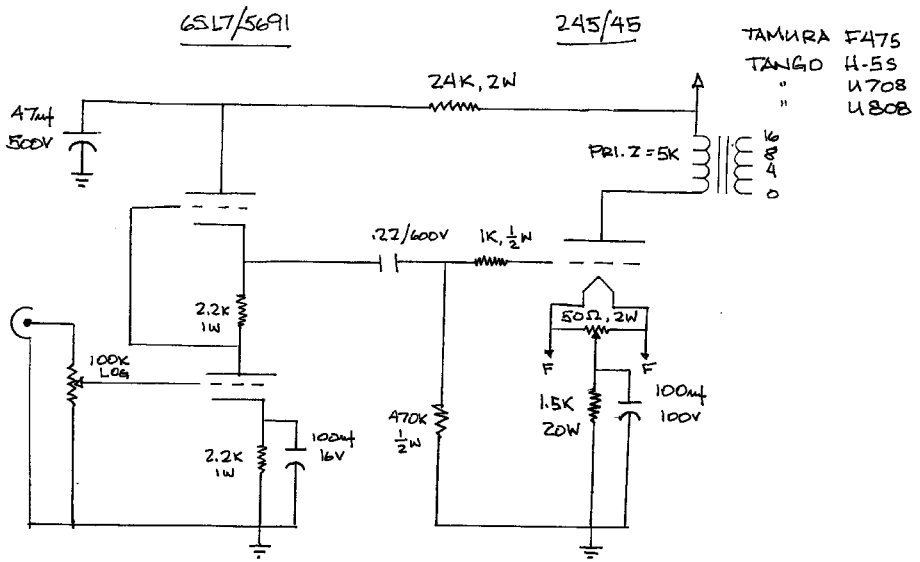
Perhaps it's about time audio hobbyists examine and extract ideas from this type of attitude in pursuit of their audio ideals.

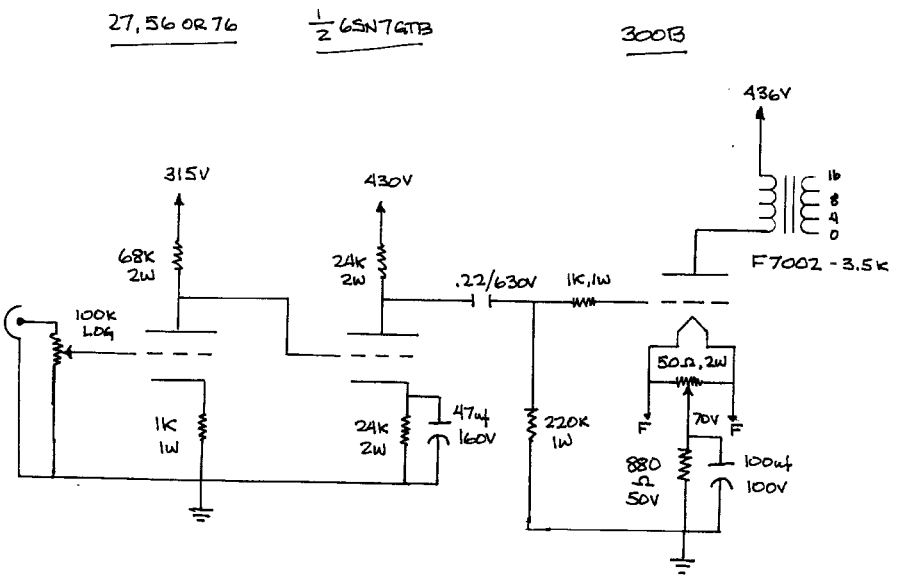




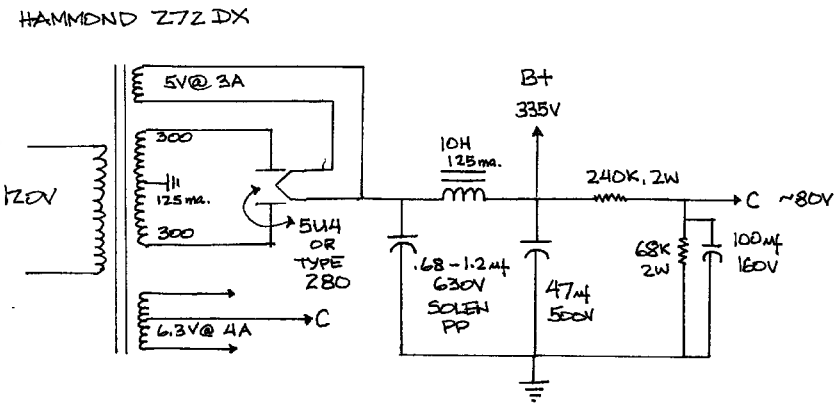


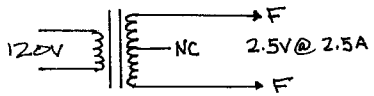
Preamp combining elements of the RCA phono stage and the Berman line stage, with battery bias for the phono stage



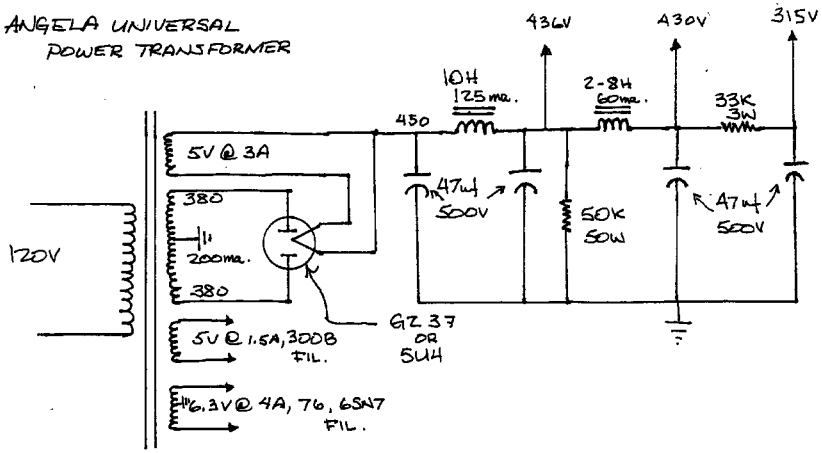


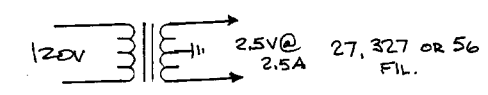
SRPP 245





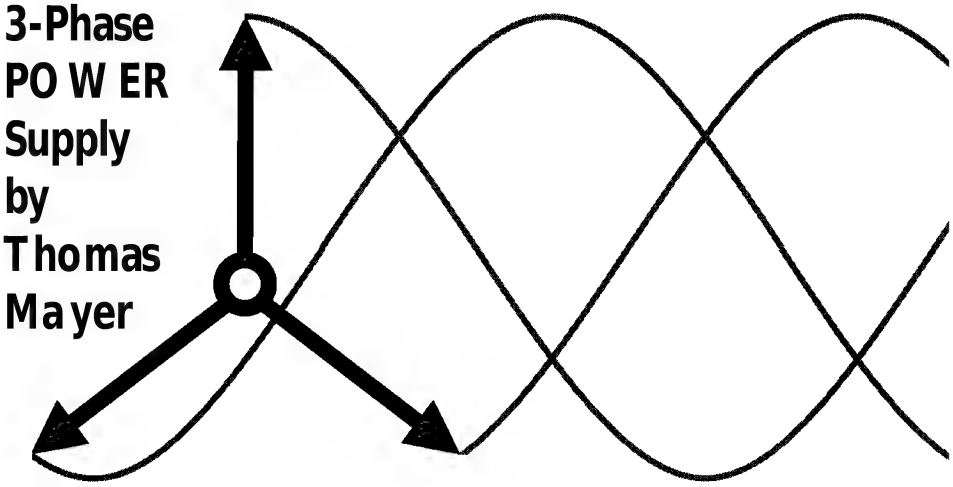
SE 300B AMP





"Esmilla Labs" single 245 and single 300B amp schematics

3-Phase POWER Supply by Thomas Mayer



Most amplifier builders will agree that the power supply has as much influence on sonic performance as the actual circuit itself. In this article I will describe a power supply topology which has been widely used for industrial and transmitting applications but which seems to be ignored by audio designers.

Introduction

The generator in the power plant typically provides three "hot" phases and a neutral. The three phases being 120 degrees shifted towards each other. In the upper part of figure 1 these three phases (marked A,B and C) are illustrated.

Usually only one phase is used in a typical power supply. This is sufficient for most applications. However some more demanding devices can benefit from the usage of all three phases.

The most obvious advantage of a power supply which utilizes all three phases is high power capability. Typically large appliances use them. But there are other advantages which are also relevant for audio amplifiers.

A three phase supply however continuously draws current from one of the mains phases ensuring continuous power transfer from the mains without the need to resort to large storage capacitors to fill in the “gaps” between conduction intervals. Single phase supplies approach a nearly constant current flow when choke input is used;however the three phase supply achieves this in a much more direct and elegant way in my opinion

The key advantage of a three phase supply for audio applications is the increased frequency of the ripple after rectification.This is actually three times higher than with a conventional supply (300Hz for a 50Hz mains, 360Hz for a 60Hz mains). This means that much less effort in the smoothing filter is required than for single phase supplies to obtain the same hum level. At three times the frequency a choke has three times the impedance and a capacitor one third of the impedance. This translates into an increased filtering efficiency by a factor of 9 for a LC stage.

However, increased filter efficiency is not the only advantage. Besides having a higher frequency, the amplitude of the ripple right after rectification is much less than that of a single phase supply which uses an input choke. In fact, after rectification the voltage contains only about 4% of ripple. Some applications which don't require very low hum levels could probably work without any filtering. Ripple frequency and amplitude can easily be derived graphically.

This is illustrated in the lower part of figure 1.The dotted lines show the rectified phases A,B and C, while the overlaying solid line illustrates the resulting DC when these are added.

A three phase rectification scheme

Obviously, such advantages don't come without a cost.Figure 2 shows a three phase rectification scheme which is called "three phase star full wave " or "series three phase full wave". There are other rectification topologies, but in this article I will only cover this one since I believe that it offers the most benefits for it's use in audio amplifiers.

The biggest cost factor of this supply is the requirement for a special three legged transformer. Three phase transformers have three separate primaries and secondaries. Alternatively three separate single phase transformers can be used. Additionally six rectifiers are needed compared to 2 or 4 for single phase topologies.

In figure 2, primaries and secondaries are connected in a star configuration. This way transformers with regular primary voltage rating can be used. Alternatively it is possible to wire the primaries in a so called delta configuration.This means that the primaries are not connected between a phase and neutral but between two phases. In the delta configuration the neutral is not used at all.

However in a delta configuration the primaries see a voltage which is higher than that on a single phase by a factor of SQRT(3) which is approximately 1.73 (400V for 230V mains, 200V for 117V

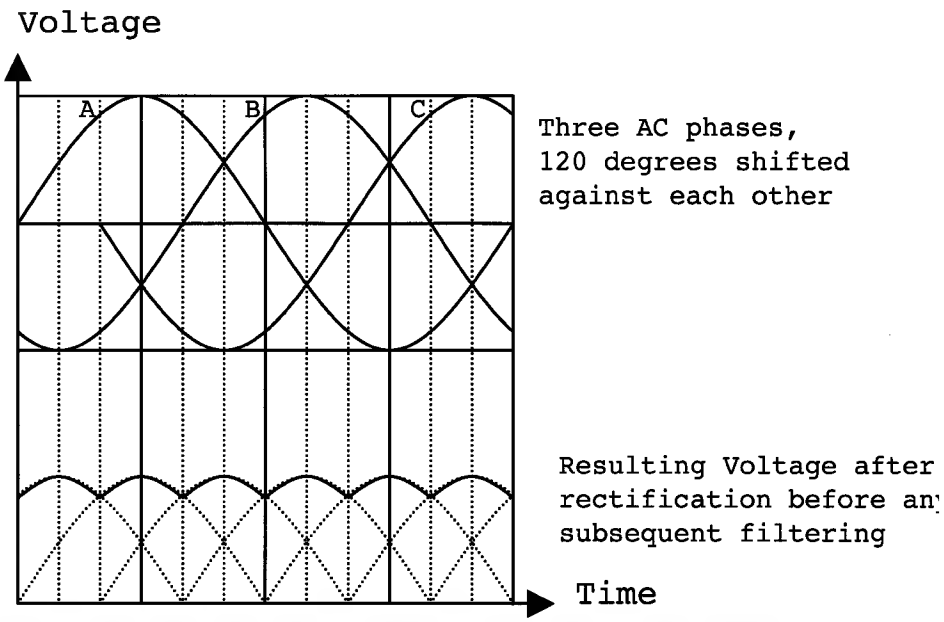


Figure 1— Shows the phase relation of the three mains phases and the resulting DC voltage after rectification. Note that the AC ripple is already very low before any subsequent filtering.

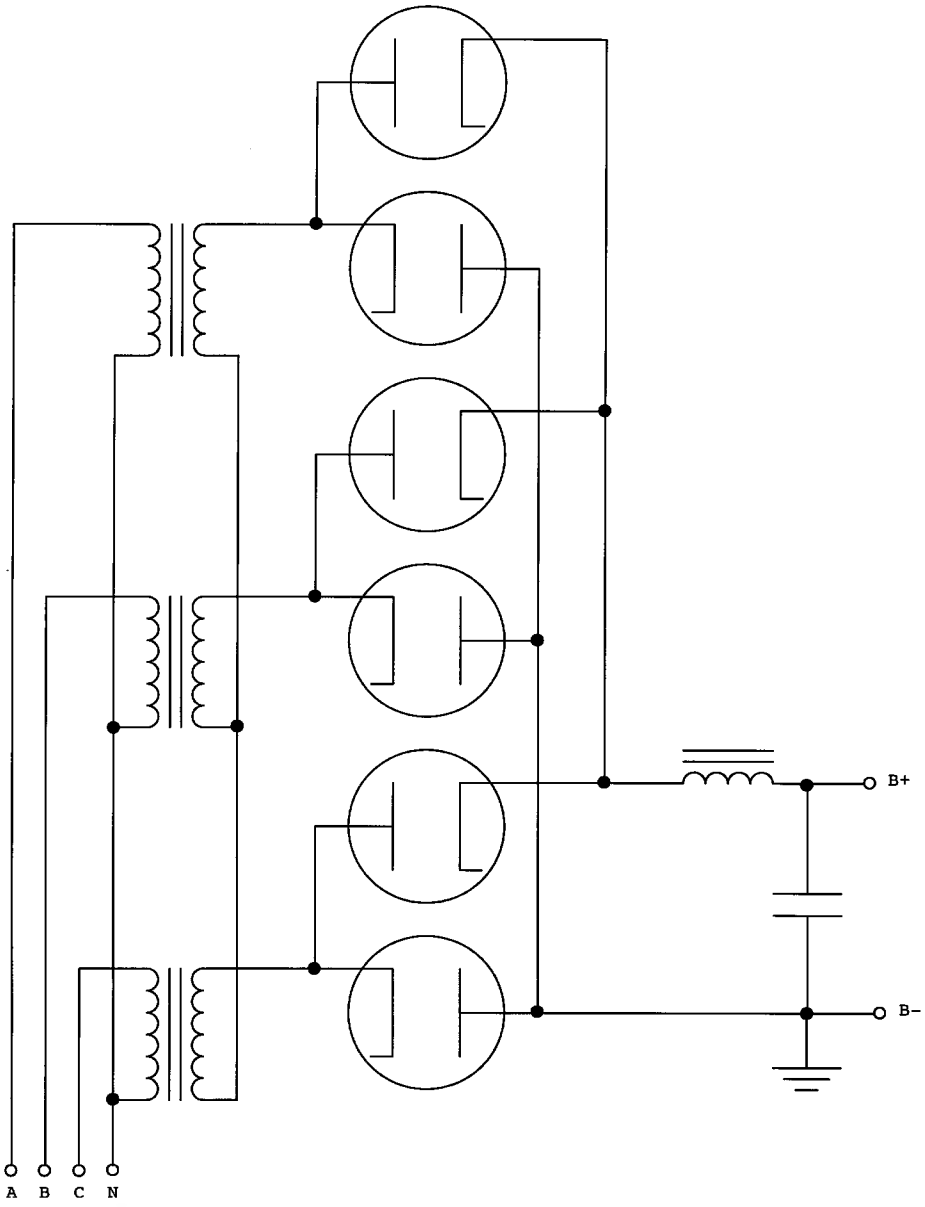


Figure 2— Simplified schematic of star-type three phase supply

mains). This would require different transformers.

In figure 2,the heaters of the rectifier tubes are not shown for simplicity. Please note however that three of the diodes have their cathodes on AC potential, while the other three are on the rectified DC potential. If the heater/cathode insulation is not sufficient or if directly heated types are used, four separate heater windings will be necessary, each biased to the appropriate potential.

Table 1 lists all voltage relationships for this scheme. As you can see the ratio between DC voltage and secondary RMS voltages is extremely good compared to conventional supplies. This means that less expensive transformers can be used which partially offsets the increased cost. Although more rectifiers are needed each one only supplies one third of the current draw. This enables the use of possibly cheaper types like TV damper diodes. And finally, less filtering is required which can easily save a LC stage. If you look at all these factors, a three phase supply could be less expensive than one would think at first sight.

A practical example

Now I will outline the design and construction of a three phase supply which I built for my SE 211/211 mono blocks. The amps consist of a 211 SE output stage which is driven by another 211 through an interstage transformer. Both stages use fixed bias. After having tried the three phase approach with an experimental set up which delivered the B+ to both stages in both amps I decided to build two separate "no holds barred" supplies. The results with the experimental supply were much better than the single phase unit I used before which used an oversized HV transformer, 872A and 1616 rectifiers and a choke input filter.

Each of the two supplies should provide completely independent B+ and filament voltages for driver and output tube. The required voltages were around 800V for the driver, 1250V for the output tube and 10V at 3.25A for the filaments. I wanted the high voltage to be tube rectified.

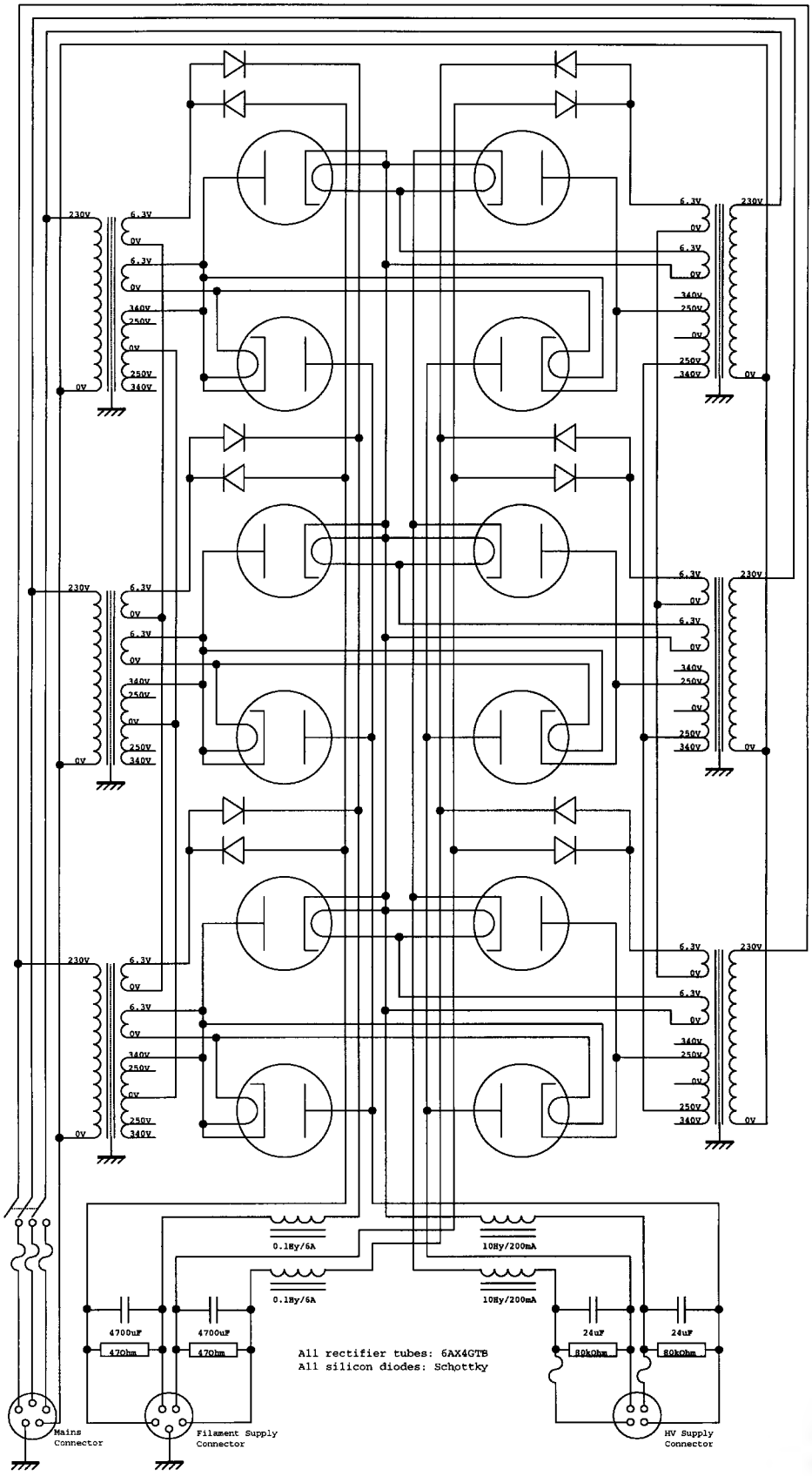
First, a decision needed to be made on the power transformers. Since three phase units are not very common I settled for regular ones. A local supplier had a stock unit which was a good fit. It has a 680VAC secondary with center tap and taps at 250V. Since the center tap is not needed this gave the possibility to obtain various different voltages (90/250/340/500/590/680). Additionally it has two separate 6.3V heater windings.

Since the driver and output stage supplies should be separate I needed 6 of these transformers for each channel.

One of the 6.3V heater windings on each transformer is used for the 10V filament supplies, while the other is needed for heating the high voltage rectifiers. The current rating of the 6.3V winding limited the choice of rectifier tubes. Since it only requires 1.2A I settled on the 6AX4GTB TV damper. For rectification of the filament voltage Schottky diodes were used.

The rectifier bank which supplies the 1250V for the output stage is connected to 3* 500VAC by using the appropriate taps. This would not be sufficient as such to reach the 1250V. The transformers provided +/- 5% adjustment taps on the primaries. I used these to beef up the voltage a bit. Additionally the secondary voltages are a bit higher than nominal since the HV windings are operated at about one fifth of their maximum current rating. The actual voltage is in the order of 550VAC. This would give about 1280VDC. With the voltage drop in the rectifiers the result is close to 1250V as required.

A driver stage voltage of 800VDC is obtained by using the 340V connection with the corresponding secondaries.



The two filament rectifier banks deliver approximately 15VDC at their outputs. Due to the DC resistance of the smoothing chokes (one in the supply, another one in the amp) just a bit over 10VDC are left at the filament pins of the 211s. This leaves a bit of headroom for adjustment.

All DC voltages (including filament) are smoothed by a choke input filter. For the high voltages 10Hy/200mA chokes from Lundahl are used. These units have an extremely low DC resistance (36 Ohm) and a high enough voltage rating between coil and core. The chokes used in the filament supplies are 0.1Hy/6Amps units from a surplus dealer. On the B+ sides the chokes are followed by a bank of three 8uF/660VAC oil caps in parallel.The filament voltages are filtered with 4700uF/25V electrolytics.

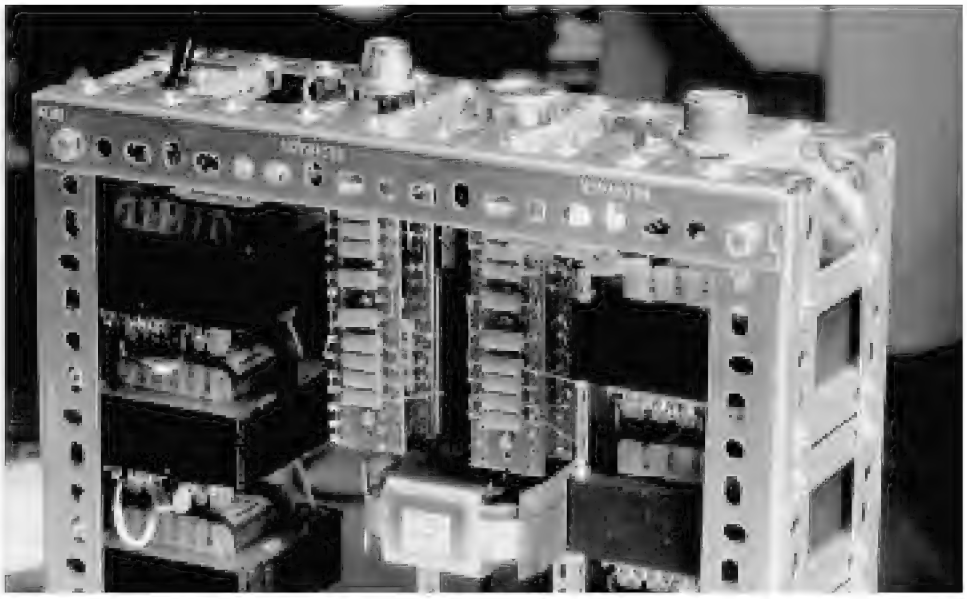
Figure 3 shows the schematic of the supply in full detail. Please note the biasing of the different heaters. The two corresponding diodes of the driver and output stage B+ supply share a single heater winding. The diodes which have their cathodes connected to a transformer secondary carry the same AC potential as the secondary of the driver stage supply of the same phase. The diodes with their cathodes on DC potential are hooked up to the driver stage B+.This keeps the heater/cathode voltage within the maximum for the 6AX4GTB. The slow warm up characteristic of the TV damper diodes automatically provides a delayed high voltage.

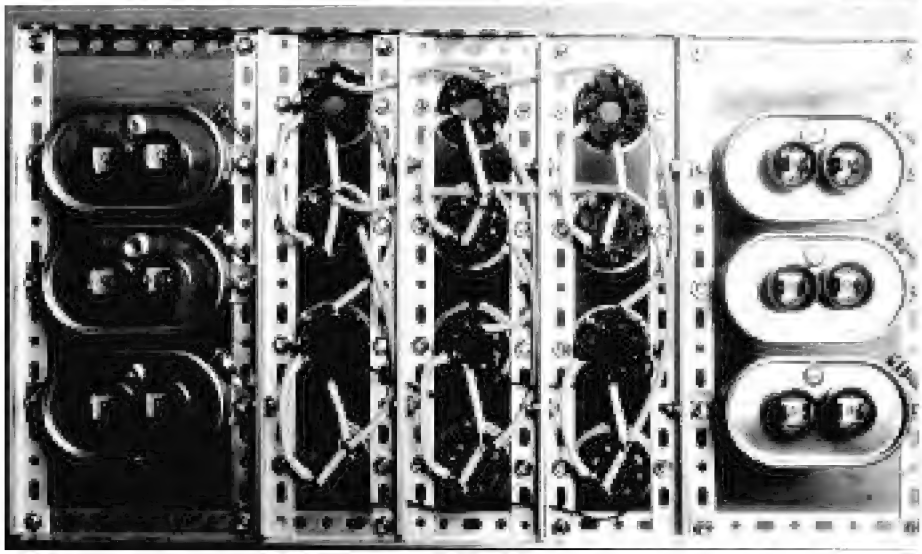
The photos show the assembly of one of the units step by step. Due to the weight (approx.140lbs) a sturdy frame construction was necessary. I used material which is intended for the construction of industrial style shelves. I mounted the units on wheels to keep these beasts movable.

Teflon insulated wires are used for all high voltage connections. Additional insulation sleeves are used to provide mechanical protection.The DC voltages are brought out on separate connectors for filament and B+.The grounds of all 4 supplies are kept separate and are intended to be connected in the amplifiers themselves.

Connection to the mains is via a 5-pin connector (3 phases, neutral and earth). An earth connection is also provided on the fila-

Figure 3— Complete schematic of supply, showing all details,including heater supplies and the bias arrangement which provides safe heater-cathode potentials for the rectifier tubes.





ment connector to allow grounding of the amplifier chassis.

Performance

The hum levels on both the B+ and filament voltages are in the mV range at the outputs from the power supply units. Each voltage has a second LC filter stage which is in the amplifiers. This pushes the ripple amplitudes way down into the micro Volt range.

These supplies enable a freedom from hum which would otherwise only be possible with regulation or by using large filter capacitors. The possible sonic drawbacks of both have been discussed a few times in this magazine. However fluctuations in the mains voltage causes the DC voltages to bounce just as with unregulated single phase supplies. This never caused a problem in my setup however, since these tend to be quite small.

No load to full load regulation of these supplies is extremely good compared to the single phase unit I used before.

Soundwise the new supplies added some real slam to the lower frequencies with subjectively extended bottom end. The amps can also be driven to higher power levels before audible distortion kicks in. But the key improvement is the very low hum level.

I used to prefer AC filaments before, but after I have lived with these supplies for a while I don't want to go back. The very pure DC on the filaments enabled a transparency of the sonic presentation which has not been present with AC heating

All positive attributes of the amplifiers which have been present with a single phase supply have been preserved.

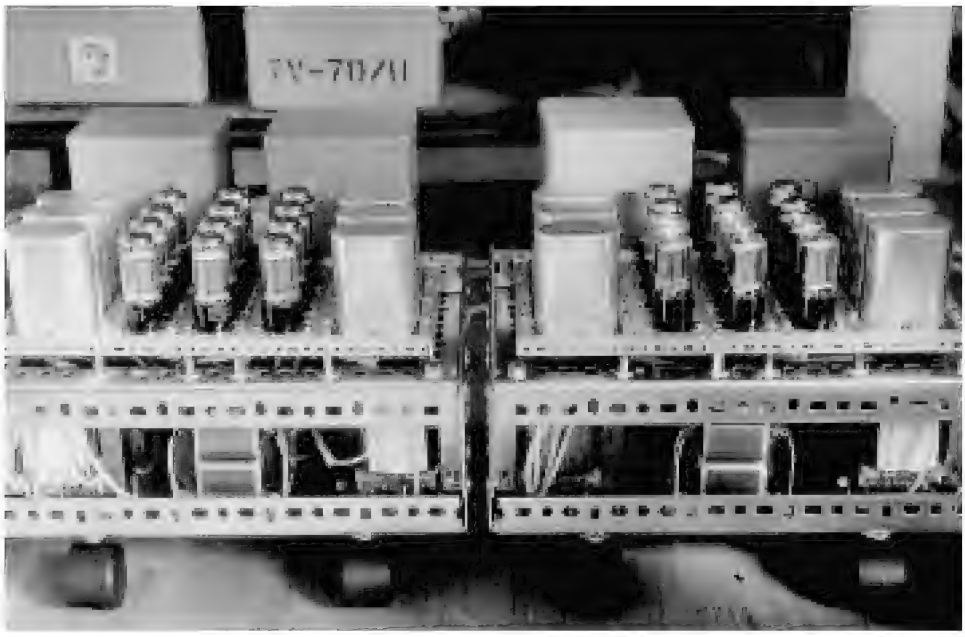
Closing remarks

Although SP readers are well aware of the dangers of high voltage, anyone who wants to try out the three phase approach should be extremely careful and not attempt to build such a supply if he isn't well aware of the hazards involved. Extra care needs to be taken when dealing with all three phases of the mains. The increased complexity of such a power supply bears much more possibilities to make a mistake which could be

Top— Underside of chassis

Mid— Subassembly with rectifier sockets and HV caps. All HV carrying cables are teflon insulated with additional sleeves for extra protection

Below— Both supplies completed and working



lethal.

When three separate transformers are used it is important that their secondary voltages are equal. Any imbalance would exhibit itself as 50/100/150Hz or 60/120/180Hz subharmonics in the ripple of the DC after rectification.This could offset the advantage of increased filter efficiency.

This article could merely touch the surface of this topic. Some more information can be found in the RCA transmitting tube manual (reprint of TT-5 available from Antique Electronic Supply) and in "Principles of Electron tubes" which is also available as a reprint from Audio Amateur Press.

If you are planning to build an amp with a no compromise unregulated supply you should give the three phase approach a thought.

The author can be reached by e-mail: thomas@vinylsavor.de

Transformer secondary voltages (RMS)

Erms = 0.427 * Edc

DC output voltage

Edc = 2.34 * Erms

Peak inverse voltage

Einv = 2.45 * Erms

Einv = 1.05 * Edc

Ripple voltage

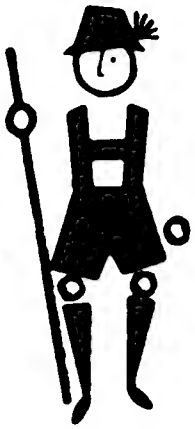
Eripple = 0.04 * Edc

Ripple frequency

fr = 6 * mains frequency

Note: voltage losses in rectifiers secondaries and filter chokes are not taken into account

The Legacy of THORENS "TD" Series Turntable Classics



by Dr. Stefano Pasini

Put on your lederhosen
and spin a platter on that
Gepanzert Plattenspieler...

In the history of home audio, the name 'Thorens' and 'turntable' are more or less synonymous. Very few audiophiles haven't bought and used, at one time or another, one of these beautifully-engineered machines, either of the Swiss-era or of the later years, when their factory was moved to Germany. Wonderfully well-engineered, built so sturdily that they look like they're armour-plated, heavy, completely reliable and, if the need ever arises, hard-working like real professional decks, the best Thorens turntables are a joy to own and a pleasure to use.

The Thorens tradition is now carried on in Lahr with models like the '521/520', the sophisticated 'Ambience', the versatile '2001' and many other excellent decks. But the two real 'Golden Classics' of this marque were born many years ago; they are as different as they might be, but the Thorens 'TD-124' and 'TD-125' were, and still are, top-of-the-line machines. Like Ian Fleming's diamonds, Thorens are forever.

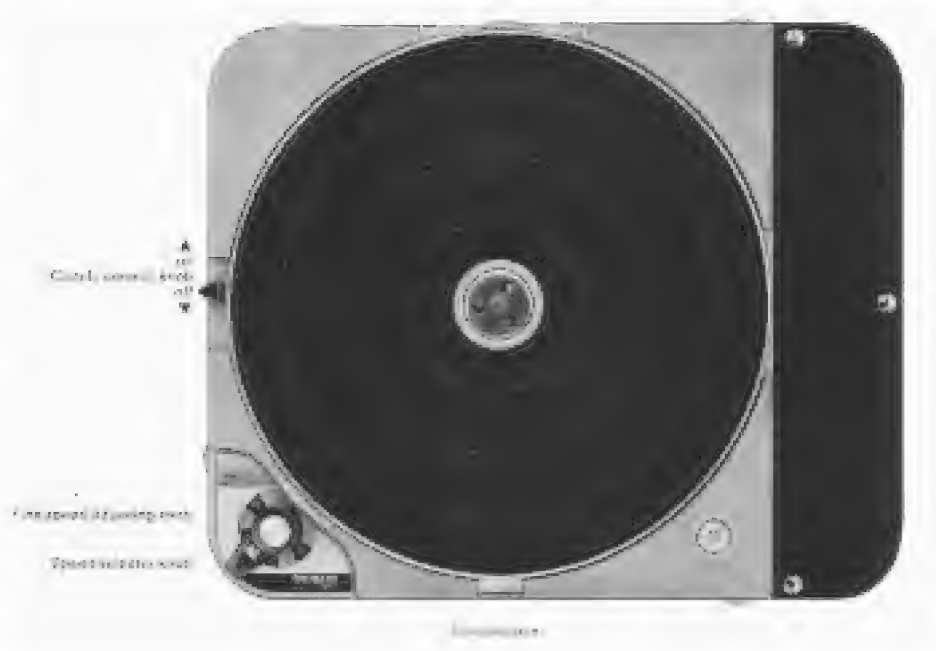
The history of Thorens began in 1883 in St.Croix, Switzerland, when Hermann Thorens founded a firm for the manufacture of clockwork for carillions, cigarette lighters, razors and harmonicas that eventually expanded to employ a workforce of 1,200 in 1929. Disc-playing Thorens machines were already well-known even before World War II, as the firm had already probed the world of music reproduction since the late Twenties with direct-drive motors (a Thorens patent of 1929!), 'Miratonal-Radio' receivers, 'Discophones' gramophones and even separate cartridges, like the 'Omnix' (1933) that required a tracking force of 'only' 110 grams, quite moderate for the times.

Switzerland just barely managed to stay out of the catastrophe of the war, and between 1939 and 1945 Thorens built, amongst other items, high-quality disc-cutting lathes for the Swiss PTT. In 1943 it introduced into its tiny home market a new record changer, the 'CD30', followed by the 'CD50', 'CD43', and various other models, simple motors and platters with no pretense of 'hi-end' performance, something for the average home customer of the times.

On the other hand, the market for sound-reproduction gear was expanding, and the pros were eager to buy new machines. After the end of the war, radio broadcasts resumed in earnest, and Swiss firms like Studer or Nagra, not having been bombed flat during the war like their German colleagues, were ready to build new advanced machines for the well-heeled professionals. Before the cautious managers of Thorens could build a deck to fulfill the needs of the radio stations, Wilhelm Franz beat them and the rest of Europe's industry with his formidable EMT '927' (1950), the Alpha and, for 27 years, also the Omega of the broadcast turntables.

The Thorens' forthcoming 'high-fidelity' turntable remained in the making for a long time. It is not unreasonable to think that in the process they exchanged data and information with EMT, as the relations with Herr Franz in Lahr had always been good. This might explain why, when the first high-quality Thorens 'TD' finally appeared, it sported a clear and utterly reassuring EMT flavour. But one may also be excused for suspecting that the Thorens managers, before finalizing the design of their turntable, had taken a close look also at the excellent Garrard '301' (first introduced in 1953). In fact the Thorens 'TD124', being aimed not at the all-out 'broadcast' market but at the wealthy amateur, is closer in design, size and philosophy to the British machine than to the German Leviathan.

The '124' was introduced in 1957, at first as a motor chassis only, leaving the choice and installation of the tonearm up to the cus-



Top view of the famous Thorens TD-124



WHAT MAKES THE TD's TOPS?

...finer for stereo...finer for mono

If you move in circles where component hi-fi is a by-word, you've no doubt heard about the Thorens TD-124 transcription turntable and its fabulous performance. But for late-comers we'd like to point up just a few of the really big features (non-technical readers may skip remarks in parentheses): • **Extra heavy table for constant speed** (10 lb rim-concentrated table insures low wow and flutter; higher moment of inertia than any similar table). • **Exact speed** (±3% adjustment on all speeds—16⅔, 33⅓, 45, 78—with built-in illuminated strobe for setting after stylus is on record). • **Easy on records** (unique two-table design permits starts after you've placed stylus, permits ⅔ rev. starts, makes cueing easy). • **Extremely low rumble** (mirror-finish main-bearing, nylon-seated ball-thrust-bearing reduce both vertical and horizontal rumble to a new low, so important for stereo). • **2-way motor rumble reduction** (both an extra-large idler and an ultra-compliant belt-drive keep motor vibration and speed variations from table). Driving parts electronically balanced. No costly base necessary (only $9.00). 50/60 cycles, 100/250 volt operation.

These are just a few of the TD-124's features. Ask your dealer to tell you the whole story on the fabulous TD-124.



Now two budget-priced TD turntables

These 4-speed turntables have same basic adjustable-speed precision-drive as famous TD-124 but you save two ways: (1) they come already equipped with stereo-wired professional arm without overhang making them ideal changer replacements. (2) Some TD features have been eliminated to save you money. But they still top the performance of every similar turntable and player on the market. TD-184 has semi-automatic operation. TD-134 is manually operated. Precision metal stroboscope (50/60 cycles) furnished with each unit. 100/250 volt operation. Wooden base only $6.00.

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tomer. That's why today you find so many '124's fitted with SME, Empire, FR-64, Shure, Ortofon or even Rek-O-Kut tonearms. Then, in 1958, the stereo record was officially introduced, and almost simultaneously Thorens unveiled its first really high-quality arm: the 'BTD-12'. Every EMT enthusiast will recognize this classic design as an ancestor of the fabled '929' professional arm.

Later on, just as Garrard re-designed the '301' to produce its '401' (1964), Thorens modified the '124', introducing its 'MkII' version in 1966. The most significant improvement was probably the installation of the 'TP14' arm with a redesigned, lighter-looking headshell, minor tweaks being at the same time applied to motor and transmission. The elegant cream paint of the '124' was thought to be old-fashioned, so, with a decision that I personally find regrettable, it was changed to a more sober (some might say duller) medium-grey finish. The speed-change lever and the speed adjustment knob were modified as well. The overall layout was unchanged since it had proven to be a winner.

The main feature of the '124'/'124 MkII' is its extremely sturdy aluminium chassis; another is the unusual transmission, designed to combine the advantages of the two main drive systems of the time, the vibration-filtering qualities of the belt and the rigid coupling of the idler-wheel. A powerful synchronous motor (which in the USA, in the style of the times, was christened 'Roto-Drive') turns a pulley and a short, thick belt, this one then driving the stepped pulley, the idler wheel and finally the heavy 4.5 kilograms cast-iron platter, whose 14 mm shaft rotates in a high-quality main bearing. It works very well, though at the price of a hefty weight (almost 15 kilograms for a '124 MkII' with 'factory' arm and plinth) and a remarkable degree of mechanical complication. You only need to compare the underside of a '301' and of a '124' to understand ....

All the moving parts of the '124' are generously oversized, to enhance the stability and reliability of the turntable. The main platter is designed to be always rotating, like a big, heavy flywheel, whilst the actual platter is the light aluminium disc placed over it.

The speed can be finely adjusted by means of a magnetic brake controlled by the owner with the rotation of a small knob on top of the speed-selection lever, and checked with the aid of an illuminated stroboscope, whose dots are painted under the outer edge of the

main platter, constantly illuminated by an orange neon bulb, reflected by a mirror and visualized through a tiny window in front of the platter. Clearly this was an advantage over the Garrard '301', which at the time offered a 'strobe' platter only as an option and without on-board illumination.

Thorens allowed for the 16 rpm record, just in case, fitting a gear for this speed. The '124' was therefore one of the very few turntables that were born with a complete choice of speeds, 16, 33, 45 and 78 rpm.

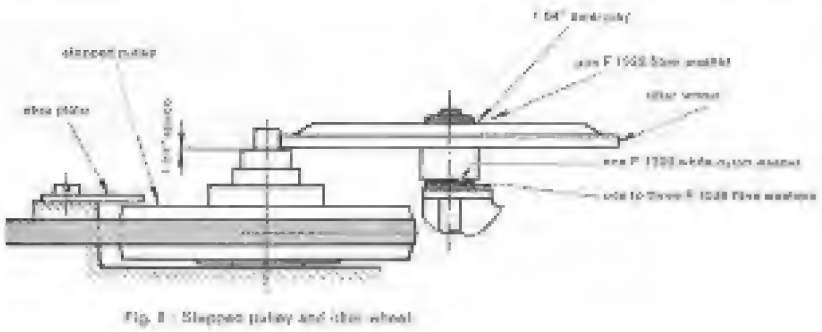
Instead of opting for a pure 'Transcription Motor' approach like their British rival, Thorens decided to offer a chassis incorporating on its right side a wooden board, rigidly fixed with three screws to the underlying aluminium chassis, that could be drilled for the installation of any given 12" arm. The result is that the '124' and its arm form a reliable, vibration-free assembly with no possible reciprocal movement between arm and platter.

Though quite expensive ($99.75 for the deck alone without tonearm at the time of its introduction in the USA), the '124' enjoyed very good success from the beginning. Its very pleasant lines and the high quality of its construction were strong selling points, and the integral armboard of the '124' was probably a real advantage over the Garrard, because, as Haden Boardman rightly pointed out in SP Vol.2 #1, in those years nearly nobody understood the need for a stable, heavy plinth to mount these heavy decks on. Most '301' therefore ended up in overly-resonating cabinets, or, worse, sprung on a board while the arm was fixed to the same, with predictably horrifying results.

Though the '124' minimises the problem mounting the arm on the same chassis as the platter, one must admit that Thorens apparently had no clearer ideas than Garrard in this area. In the 'MkII' instruction manual, They advise customers that "....additional protection against acoustic feedback.... can be obtained by mounting the board freely on thick rubberhair or foam rubber mats. Special steel coil springs (parts CB 1172 and CB 962) are available as accessory upon request, to be used in place of the rubber dampers for installations where the turntable is submitted to strong extraneous vibrations...." You can sneer at these words, but this was the state of the art in 1966.

The winning image of the '124' had a positive effect on the other products of the Thorens range, like the much cheaper





Underplatter view of the TD-124,showing drive system and detailed sketch of idler wheel mechanism.The stepped pulley is belt-driven.

'TD184' (1958), 'TD134' (1959) and the very effective 'TD135' (1961), the TD-135 had no strobe nor separate armboard, but offered the same excellent drive system as the '124' with pitch control and the 'BTP12' tonearm of the more expensive model, later fitted with the 'TP14' when the 'MkII' version appeared. A '135 MkII' is a pleasant scaled-down '124/II', weighing 8.5 kg with a 2.9 kg platter on a 10-mm main shaft; the presence of a magnetic brake meant that you could vary its speed, but, lacking the built-in strobe of the '124', you had to plop a strobe disc on the platter.

An interesting but short-lived attempt to build an affordable high-quality deck was the 'TD121' (1962), a '124' without strobe and speed control but the same drive system, platter, bearing and tonearm. It was a bit like Porsche's strategy when they built the simplified 'Speedster' to make the '356' more affordable for the money-conscious American public. The reaction of the customers was not as enthusiastic as for Stuttgart's racy machines: though the performance of the '121' was very good, but a saving of $20 wasn't enough to lure the customer away from all the bells and whistles of the '124', so one either opted for the really cheaper '135' (and its speed control) or went to the top, buying the flagship of the range.

A very intriguing variation of the family was the 'TD-224', a fascinatingly complicated record-changer based on the '124' but with an unique feature: it could play a stacked pile of records not amassing them one after the other on the turntable, but actually

Thorens' newest turntable with more freedom of choice!

THORENS, the world's leading transcription turntable manufacturer, has developed a new turntable — the TD-150. It offers the serious music lover a Thorens quality precision turntable, and it gives him freedom to select or change over conveniently to any tone arm or cartridge his system requires.

And because of its price, the TD-150 permits you to place your emphasis on the tone arm and cartridge — which is where it should be. For knowledgeable hi-fi enthusiasts know that the total performance of a record-playing system is no better than the tone arm and cartridge which track the disc.

Yet the TD-150 sacrifices nothing of Thorens' world-famous quality. Its features include:

- 12-inch, 7½-pound precision balanced non-magnetic platter.
- Two low-speed synchronous 16-pole motors on one rotor shaft to assure constant and smooth in-phase perfect speed.
- Uni-suspension — tone arm board and platter are a spring-loaded suspension system, minimizing vibrations and acoustic feed-back.
- Interchangeable tone arm mounting board.
- Dimensions: 15⅝" wide, 12⅞" deep, with a total height only 3¼".

If you wish to make no compromises in the sound of your record playback system, a Thorens transcription turntable should be your choice.

From the still unsurpassed TD-124 Series II, 4-speed transcription model at $149.50

or the completely integrated TD-150AB (a BEST BUY) at.....$99.75

to the new "Freedom-of-Choice" TD-150 (base and tone arm not included) at only $85

there's a Thorens quality turntable for every need . . . and every budget.

Satin walnut base (WB 150SW) $10.00

Dust cover (TX22) $12.50

THORENS TD-150



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changing them!. A 'robot' arm picked the record from a massive separate arm and returned it to this resting place when it had been played. An impressive machine, but its sheer size was probably excessive, like its weight and, of course, its price: the '224' was nearly twice as expensive as a '124'. As a consequence, the production figures of this weird, high-quality 'changer' were always quite low, though it was built for a record six years, from 1962 to 1968, always with the same '224' designation. There never was '224 MkII', like there never was a '124 MkI'.

A '124' or a '124 MkII' is one of the dreams of today's vinyl-oriented audiophiles, and for good reasons. Endowed with a well-engineered, heavy plinth, like Mr. Martin Bastin's amazing all-wood designs, and a suitable arm, its performance is staggering. And if you own a completely original, well-preserved deck of this series in fully original condition you will appreciate its build quality, its flavour, its unique style. It's one of those objects that you simply like to have around at home.

The second part of the Sixties saw a steady increase in the tenor of life of the Western Hemisphere. The citizens of Germany, Italy, France and the United States for the first time enjoyed the luxury of having some spare money and the time to spend it. Listening to good music became fashionable, and the second-rate sound of the old home systems, intolerable. The Japanese were the first to understand that there was a market that was just about to explode for good sound-reproducing equipment, and that this request would not be satisfied by the pricey high-quality components manufactured by the traditional firms.

Until then McIntosh, Garrard, Harman-Kardon, Marantz, Klipsch and, of course, Thorens had catered mainly for the needs of a restricted élite of wealthy individuals: the Far East manufacturers looked at the other end of the market instead, building cheap amplifiers and tape decks as copies of the Western originals, adding some convenience of use, a pleasant appearance, absolute reliability and, of course, a very low price. Their success was guaranteed by the inability of the 'classic' firms to react to this trend, to the general request for cheaper high-fidelity equipment for the home enthusiast that didn't personally own a bank.

To give credit where due, Thorens was one of the few manufacturers that had steadily explored the possibilities for less expensive offerings, and the proof is in models like the '121' and '135'. But the diffusion of high-

fidelity listening in lower-income households often meant also a troublesome placement of the equipment. Whereas in the past the wealthy enthusiast could engage a cabinet-maker to build a suitably sturdy housing for his '124', the newcomer more probably placed the turntable wherever his house (and wife) would allow it. Any flat surface large enough was considered, sometimes even the top of the speakers, with predictably disastrous effects on the acoustic feedback of rigidly-suspended, massive idler-wheel machines with their rigid coupling between motor and platter.

Though its sonic performances in the right environment remained absolutely excellent, the '124' suffered from this new situation, and a new technical layout was therefore necessary. It was also indispensable to renovate the styling: the saying of the racing world that "there is nothing looking as old as last year's racing car" is very apt to describe the difficult marketing situation of the high-quality, expensive Swiss deck that, even in the improved 'MkII' form, was looking really antiquated to the ruthless eyes of the mid-Sixties customers, taught by the Japanese to look for slimmer designs. Low-chassis and lightweight construction meant 'new', 'fashionable' and therefore 'good', 'desirable' and massive Thorens or Garrard idler-wheel decks were junked, as were other old classics like the towering Empire '398-598', the Rek-O-Kut 'Rondine De Luxe' and the Russco or Gray broadcast machines.

Before the introduction of a new product, Thorens had to rationalize its production and lower its production costs, and this meant that it was impossible to continue to produce in a country with labour cost as high as Switzerland. After a brief and unproductive marriage with Paillard (maker of the Bolex cameras) lasting only from 1963 to 1966, Thorens moved to Germany and established its new HQ in Lahr, in the Schwarzwald, joining forces with EMT to create 'Thorens-Franz AG'.

Lahr is in an area renowned for classic clockwork, where Dual, Perpetuum-Ebner, Papst and other important firms in the audio field (many of whom are now sadly extinct) had their factories. For a while, Thorens-Franz AG's mailing label carried both the logos of Thorens and EMT, and the stamp of the Wettingen, Schweiz, Post Office. (Things here get a little confusing even for the historians).

The need for a new product philosophy was addressed in a typically thorough way: the complaints about the sensitivity to noise floor and acoustic feedback of the rigidly-suspended '124' and '135' led to the design of a completely different machine, the innovative mid-line .'TD150' (1965). Its style was completely different from its predecessors'; compact and slim-looking, but still weighing 8.5 kilograms, with a low profile and a modern appearance, the '150' was a bold step forward for the tradition-oriented manufacturer. Instead of an idler wheel transmission on a massive, rigidly-suspended chassis, it had a floating subchassis, a tiny motor and a comparatively simple belt drive. This was the first Thorens with the 3.4 kg two-part main platter that was subsequently carried on with only minor modifications up to today's models. The belt moved by the motor runs around the inner, smaller platter, a thick light-metal cylinder with a diameter of 160 millimetres that turns on a 10-mm shaft; the main platter simply lies over it. Clearly, the accuracy of the machining of the two parts along the interfacing ring is crucial for the good functioning of the system.

The new architecture proved to be quite successful. The '150' quickly earned a reputation for being very quiet. Its floating chassis was able to insulate the record/stylus interface from the external shocks providing an effective barrier against acoustic feedback. It was a simple machine (it had only two speeds, 33 and 45 rpm, no pitch control, no stroboscope) and its first arm, the 'TP13', probably wasn't very good, so many '150's were fitted with aftermarket tonearms, but it worked well and it was comparatively inexpensive, enough that it actually was a viable alternative to the cheap turntables coming, in tidal waves, from Japan.

The new Thorens was available from the factory in four versions, as for later models: 'TD150 AB' was the complete deck with arm and base, the 'A' had tonearm, no base, the opposite of the 'B', whilst the 'TD150 had neither arm nor base. It was an instant success, and this paved the way for the replacement of the aging '124', a completely new product designed in the facilities of the fabled 'Geratewerk Lahr'—in 1968, Thorens finally unveiled the 'TD125'.

It was a timely introduction. Just at the moment when mass-market hi-fi began to explode, Thorens offered a thoroughly top-of-the-line turntable that combined the best of both worlds, i.e. high quality, quietness, and attractive styling in a product that was evidently of a class of its own, and that did not have to fear any Far Eastern rival.

These qualities come, at least in part, from the thoughtful application of the solutions previously discovered on the '150' and '124'. Like its direct ancestor, the '125' has an integrated but detachable armboard, a strobe and a pitch adjustment, but the motor, substantially lighter than it had been in the '124', is controlled by an electronic system, thus allowing for the deletion of the magnetic brake.

Like the '150', the '125' is belt-driven and has a floating subchassis, but both the main frame and the suspended parts of the chassis are much beefier and heavier, putting the '125' in the same weight class as the '124'.

These interesting characteristics were assembled in a very heavy, stable deck with a unique styling. While the '124' had the overall appearance and finish of a vintage Swiss medical machine, the '125' was a sort of Sixties-German-hotel-furniture design, brushed aluminium mixing with straight-grain wood in an extraordinarily attractive design. The three laterally-sliding switches on the front panel (two for the machines sold without a stock Thorens arm and therefore without 'factory' arm lift) are still instantly recognizable as a trade-mark for that model, which also sported the added convenience of a hinged, spring-supported, high-quality Perspex cover.

The stock arm was the 'TP25' with the 'TP50' headshell (now very scarce!), a classic design that was a nice piece of kit for the money. A really unusual feature of the '125' was the choice of its three speeds: 33, 45 and 16 rpm. No 78 rpm! A very unusual, some might say weird, decision.

This layout was carried on in the 'TD125 MkII' introduced in 1972, improved with the provision of a friction device to smooth the start of the rotation of the platter, a different mat, and a better tonearm—the all-new 'TP16', a high-quality, still undervalued straight arm that was to be Thorens' battle axe for many years to come.

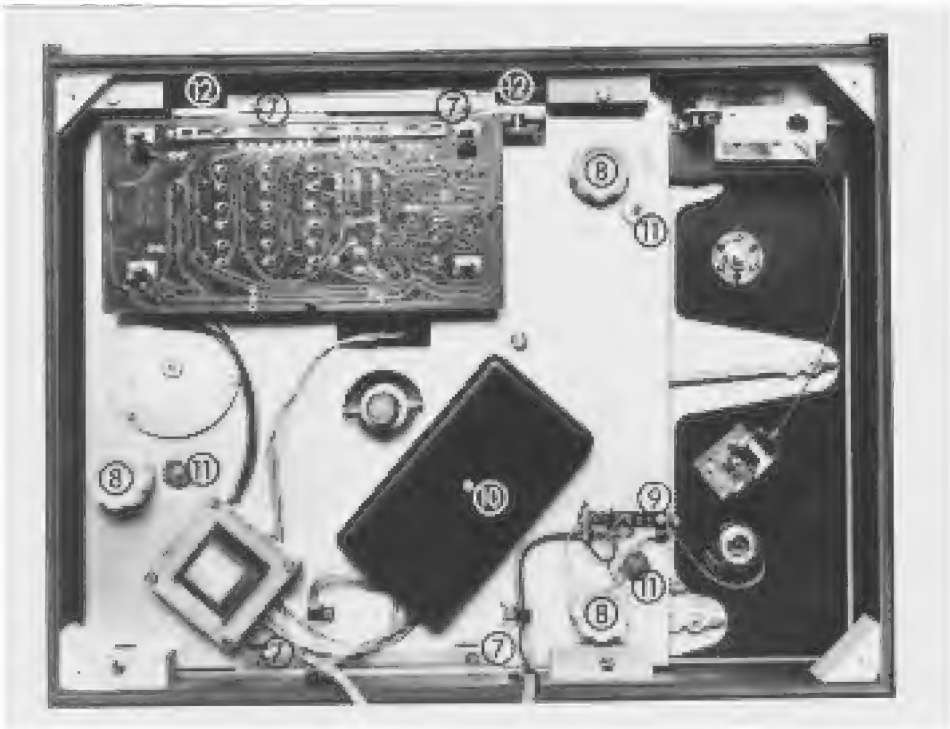
Cleverly, the '125' was designed to be adapted easily to all the main markets, from Europe's 220 Volts/50 Hertz to America's 110 Volts/60 Hertz. Overlap between the production of the '124' and its heir was very short, almost non-existent.

The armboard design of the '125' is quite different from that of the '124',which is screwed on a metal frame on the right side of the main chassis. Being a part of the chassis' casting, this frame is unmoveable and makes the installation of some 12" and most 16" arms quite tricky on the '124'.



1- AC mains On/Off switch
2- Speed Selector (16/33/45 rpm)
3- Pitch control wheel
4- Stroboscope window
5- 45 rpm record adaptor
6- Arm mounting board fixing screws
14- Tonearm lift control

7- Base fixing screws
8- Levelling knobs
9- Tonearm wires connector
10- AC fuse holder w/ protective cap
11- Chassis 'Safety' retaining nuts
12- Slide buttons fastening screws



Thorens TD-125 Top and bottom views

In the '125', the armboard does not have such limits, since it lies on three supports sticking out of the right side of the main chassis without any metal frame surrounding the edges. Therefore, even if the stock board and base supplied with the armless '125/125 MkII' were still not wide enough for 16" arms like the SME 3012, it was easy to fix the problem. The customer wanting to install his 'FR-66' or Grace '565' could order item #JP512, a factory-made conversion kit featuring a longer control panel for the base and a wider board, or simply make a custom base and wider board by himself. This voided the use of the mounting frame #CE 509, designed to install the turntable into 'furniture'. To stiffen the suspension of the '125' it was also possible to order purpose-built rubber grommets (#CB 909) to replace the chassis' springs.

The '125' design was so appealing, and its performances in terms of rumble so good, that EMT, involved from the beginning in the design of this model, developed a professional version. The 'EMT 928' was basically a '125' with a reworked electronic system, a much more sober look (all grey and black) and a '929' tonearm. It's obviously the 'definitive' evolution of the '125' design: it's heavy (15.5 kilograms), complicated, expensive, and extremely fascinating. Its performance is even better than the Thorens products, owing to the excellent characteristics of the EMT '929' tonearm, and also because of its completely different chassis.

Belatedly admitting that the wooden separate armboard of the standard deck isn't completely satisfying, at least for professional standards, the '928' upper deck is a single-piece metal casting. The hardware is all precision grade, as befits a beknighted EMT product. Wilhelm Franz decided for a different range of speeds as well, so the '928', very sensibly, offers to its users the joys of 33, 45 and 78 rpm, which was exactly what Thorens should have done with the '125' in the first place.

The '928' also has a stylus illuminating device and can be fitted with transformers for the use of the excellent EMT 'TSD-15' cartridges (this was model '928 003'), a hugely stiffened suspension— a bit like the much later 948/950, and a splendid acrylic-felt platter. All in all, a superb, if somewhat cumbersome-looking, deck.

Unfortunately, the belt drive proved to be unfit for a professional usage, and as the '928' cost almost three times as much as a '125', it couldn't be a real contender in the money-conscious amateur market of the

times. The '928' was therefore quickly dropped and the German firm went on to develop its own formidable direct-drive turntables ('950', '948' and '938'). The '928' was the last EMT model produced while Wilhelm Franz was still alive (he died in 1972) and it's a clear proof of the high regard of the 'Thorens-Franz AG' people for the basic design of the '125'. Though scoffed at by EMT traditionalists, it is a really wonderful machine. If you fancy this kind of turntable, you can't find anything better than a '928'. It's very expensive, but extraordinarily fascinating, really the ultimate '125'. Grab one if you can... Trouble is, they made very few '928', so they're probably the rarest of all the EMTs now and priced accordingly.....

The '928' story confirms that the design of the '125' is really extraordinary, so much that even dead-serious professional-oriented people like EMT thought that it deserved their sacred logo. Never mind know-it-all experts claiming that, apart from the monumental 'Reference', the '124' is the only Thorens to have. The '125' is an all-time classic, and the 'MkII' was, and I want to say that it still is, a formidable turntable. Its solidity, balance, and overall quality actually beat every other 'mainstream' deck on the market in those years. Considering its high price, it has been a real best-seller.

In USA, the '125' was quite expensive: in 1969 you would pay $280 for a 'TD125', $385 if you ordered the classic Ortofon arm, and it was a lot of money when an Empire '398' cost $199 dollars, an 'AR' was $78 dollars, and a Dual '1219' semiautomatic turntable was offered at $159.50.

Not that it was much cheaper in Italy—a 'TD125 MkII' in 1972 cost 175.000 liras as a deck or 235.000 with the 'TP16' arm, and that was some money. To put things in perspective, the last great British machine of its kind, the Garrard '401', was at the same time sold at 140.000 liras (obviously without arm or plinth). The market success of the '125' helped the sales of the cheaper 'TD165' (95.000 liras) and 'TD160' (110.000 liras), both introduced in 1972, as heirs to the '150'. These smaller decks sold like hot cakes in the sellers' market of the time. Thorens, in the first half of the 70s, was quite a fashionable brand.

It's a pity that, having reached such a formidable peak of functionalism, styling and performance Thorens didn't stick to its guns longer. In 1974 the '125 MkII' was suddenly replaced by the 'TD126', a new deck



The EMT '928'— Professional version of the Thorens TD-125

with the same engineering concepts, more electronics, a larger chassis to accommodate longer arms (but still not the 16"), 33/45/78 rpm, and illuminated pushbuttons instead of sliding switches on the control panel. If you look at it as an improvement over the '125 MkII', you'd probably be deluded, as the performance isn't significantly better while the price, with the stock 'TP16' arm, was much higher. The '126' was good, but not good enough to replace its almost perfect predecessor, over which it didn't offer real advantages.

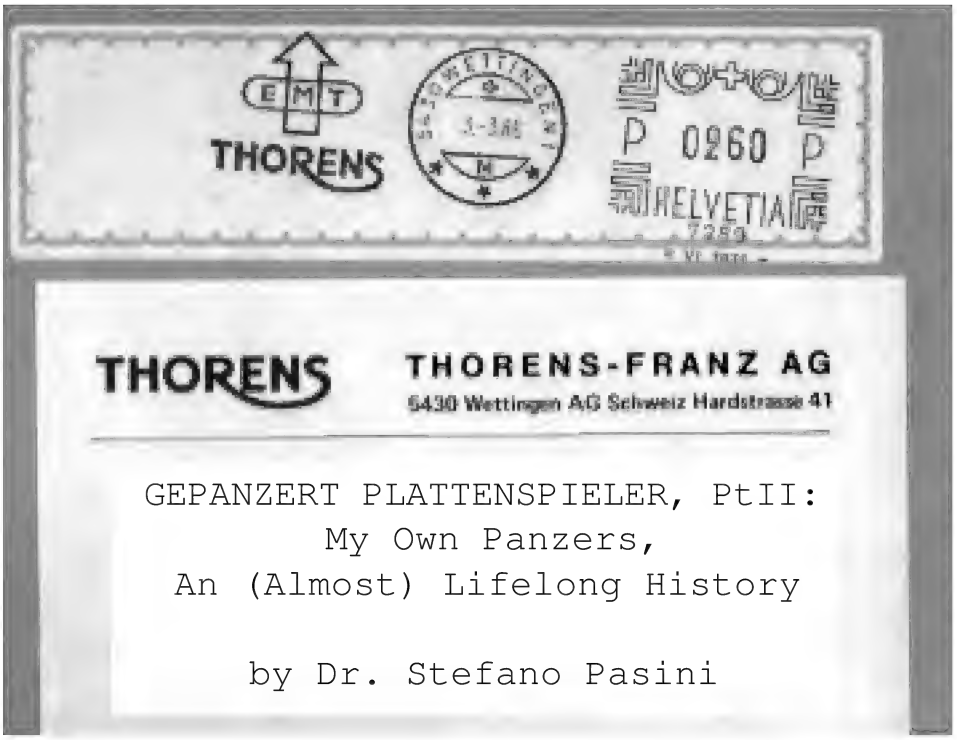
In hindsight, the '126', though a decent turntable, was the beginning of a long downslide for the Thorens name, 'Reference' notwithstanding. The arrival of the CD (1982) and the subsequent boom of digital audio destroyed the turntable market almost overnight The firm went through a lot of troubles before being rescued a few years ago by wealthy investors who are carefully rebuilding its name and product range.

Now 'Thorens Audio HiFi-Vetriebs-GmbH', owned and managed by Herr Helmut Leitner, is a small, healthy firm that builds a complete range of really excellent turntables and tube electronics. Mrs. Evelyn Schmidlin, at the Export-Department, is as helpful as one can ever hope and she cares for the requests of foreign enthusiasts with real attention. Thorens today has factories both in Lahr and Berlin, and, although the famed 'Geratewerk' sadly doesn't exist anymore, Thorens' quality level is still very high. The '2001 Isotrack' turntable is one of the best decks for the money I've heard recently.

A little-known but really amazing fact is that for the 'classic turntable' enthusiast and owner, Thorens offers a real service lab where it is possible to service, repair and restore your old deck. And I don't mean antique '316's or 'Prestiges', I mean any Thorens built since the '124'. They're quite busy these days, as requests for service and restoration of classic Thorens have boomed. The spare parts catalogue is two inches thick, and the kind lady managing the service department, Frau Renate Schmidt, remembers all of them by heart....

It's quite inspiring to see a new firm, firmly oriented towards the future of high-fidelity music reproduction, being still very much faithful to tubes, vinyl and their own old, fabulous turntables. Looking at their record, you understand that you can buy a new one with confidence, and if you can find a shop that has one connected in their listening rooms, I'm sure that you will. As soon as I can test one in a proper listening room (my own, for example....) of those new, wonderfully-designed and built Thorens, I'd probably buy myself a '2001' or an 'Ambience'...





GEPANZERT PLATTENSPIELER, PtII: My Own Panzers, An (Almost) Lifelong History

by Dr. Stefano Pasini

I bought my first '125', second-hand, in 1975. It was a perfect 'MkII' with a SME 3009 arm and it was like a Lamborghini and a Jaguar rolled into one piece for my young eyes and near-empty pockets. After a while, desperately wanting a second turntable (remember when the amps had TWO phono inputs?), I bought a fourth- or fifth-hand '124' for what amounted to, I think,$10. It was a first series, in perfect condition, with its original arm but no base, so I built one and connected it—and was shocked by its quality.

Of course, I couldn't admit to my fellow enthusiasts that I thought that a turntable that was considered just an old idler-wheel piece of junk could be as good as a neat modern '125' or one of the new fashionable direct-drive decks coming from Nipponia, but, even being no audiophile (I wouldn't dare to tell you to which piece of transistorized garbage I had hooked the Thorens at the beginning....) I was stunned by the clear sound and utter silence of that allegedly 'obsolete' turntable.

Years passed, amps and speakers and tape decks and tuners and Michells and EMTs and Voices of the Theatre came and went, but I always had two or more Thorens around. I own twelve of them now, and they never let me down. Even the cheaper 'TDs' have their dignity, and even the more desperate wreck can be easily resuscitated, something you can say only of a few top-grade products.

These days, I listen to a EMT '950' with '929' arm and an EMT XSD-15 in my main system, to a Garrard '301' on a Shindo plinth with an SME 3012 and a Denon 103 in the second (the EMT is infinitely better....) and a special 'customized' Thorens '125' in my third system.Somehow, this the one I love most. I mean, the EMT is absolutely admirable in its ruthless efficiency, but it's a machine that's untouchable in its perfection, if you modify something you would very likely spoil it. Granted, the Garrard has its 'Olde Worlde' charm and all that, but it's someone else's recipe, not mine.

With the Thorens decks, I enjoy a much more personal approach. I keep most of them absolutely spotless, in mint condition for my personal delight, but the ones I bought for $10 or $20 during the Eighties, often half-wrecks that I rescued from the scrap heap. Those are the underdogs, the forgotten heroes that I really love. I like to restore them, rebuild all that I can, and then modify them according to what I read and/or what I think. Yes, I like to modify some of my decks.... boy, do I ever tweak them! And I've never found one that answers so positively to tweaking as the '125'.

I've worked a lot with the '124', the '301' and the '401', plus many other decks, but the '125' remains my favourite, because it is wonderfully compliant. I mean, build the '124' a wrong plinth and you risk a dire degradation of its sonic qualities. This simply is not a concern with the '125'. So let's see together what we can do to improve the sound and/or operation and appearance of our Thorens.



My own trustworthy TD-125...

Before we talk about 'tweaks', however, let me utter a cry of pain. Now that vinyl is fashionable again all around the world, and that real or presumed audiophiles have discovered the qualities of turntables like the '124', the '301' or the EMT '930', there is a rush to buy those elderly decks, then, unfortunately, some of them are then heavily modified with the dubious idea of improving their performance. I cannot see how a comparatively uncultured Far East amateur can judge himself to be better than Hermann Thorens, Wilhelm Franz and their all-German-speaking engineering teams.

If the modification only involves secondary, easily replaceable parts (cables, connectors, etc) I'll let the offender go with a warning. However, I strongly object to the barbaric acts committed on decks that arrived to 1999 in a perfectly original, unspoilt condition and now have been drilled to fit a second arm, cut to make space for a quartz-controlled supply, and generally butchered to give to its owner the aura of a 'dedicated audiophile'. I think that this kind of barbarism awards its perpetrator only the label of 'culturally impaired'. Unless one is prepared to recognize the real historic value of an old classic deck, he'd better stick with cheapo CDs. What can you do with those guys? I don't know, either, though *electrocution* is one of my ideas.

Of course, this does not apply, as I said before, to an abused wreck that you rescue from the garbage can. In this case, since originality has been lost forever before you found it, you can try something new and maybe useful on it. So I'm telling you what I have done in the past and things I'm still doing, but I am asking you to refrain from modifying any original deck you might find.

WARNING: what follows might be a rude shock to some 'purists'.....

Servicing a used '124' and '125' (and any other vintage Thorens, in fact!) is easy, provided that the deck is complete and the motor or electronics have not been hopelessly burnt. Thorens always used good materials, so usually you need only to strip, clean, polish, and lubricate the machine, checking all of its parts carefully.

In the process, you will have the chance to use a whole lot of weird and potentially harmful instruments of your choice, something I always relish. Being an eye doctor, I enjoy the benefit of taking a long hard look at the idler wheels' rubber and at the stylus tips with my biomicroscope, while to pick up turntable noise there's nothing better then the old, dear stethoscope. I've used it on turntables since I was a junior medical student (that's 20 years ago). Lucio Cadeddu, the Editor of the famous on-line Hifi magazine 'TNT', one the more interesting and outspoken online audiophile magazines, has been one of the first connoisseurs to spread the word about this device and its 'audio' use.

The stethoscope is a revealing tool. Place it on the plinth of a running deck and you will hear, more often than not, all kind of noises, thumps, whirrs and hums. Not even a Tektronix can give you as much information on the condition of your deck, I am sure. Using the stethoscope 'before' and 'after' any procedure will not tell you if the modification has improved the musical quality of the turntable, but surely will help you to understand if you have solved a problem. I use a German-built stethoscope, of course, hoping that my Thorens will feel better for that. I also use an oscilloscope, but it's a simple machine that I use mainly for the tracking of the hums along the signal cables.

What you will learn, using the stethoscope, is that a high-level belt-driven deck is usually far more silent than a comparable idler-wheel job, on par with excellent DDs. (I hear purists and idler-wheel junkies frown.) The '124' is not a noisy table, but you will hear distinctly any 'flat spot' of the idler, if, unluckily, yours has one.

You will also hear bearing trouble easily, as its resulting rumbling noise is easily detected, but it's not easy to fix unless you decide to change the bearing, so, while you have the turntable stripped on your bench, it's worth checking carefully the main shaft and sleeve. This bearing wear can also occur in belt-drives, but less frequently, probably because the belt pulls less strongly on the platter and exerts less sideways force on the main shaft than a spring-loaded idler-wheel system.

Either way, a trick worthy of a used-car salesman will help you: putting a more viscous oil in the bearing will help reduce this noise. 99% of the times a thorough cleaning and lubing will make your Thorens once again as good as new.

That's probably why I love using Castrol GTX3, a 'thick' oil, instead of other very sophisticated products. I once tried the 'factory' EMT oil, and it's good if the bearing is OK, otherwise I stick to the Castrol, which is also much, much cheaper. I'd like to try the 'Mobil D.T.E.' medium-heavy oil that EMT recommended for its '928' as well, but I can't find it in Italy. Belts and idler-wheels will have to carefully cleaned with warm water and soap, then rinsed. NEVER use turpentine, alcohol, etc, on old rubber.

Power cords and connecting (signal) cables of the decks built before 1990 are quite mediocre. They weren't very good to begin with, so now that they're old, they are usually very bad. If you have a stock '124' in pristine condition, let it alone with the stock cables and use it for display purposes. If the deck was found in bad condition and you have to rebuild it anyway, junk the old cables and go for new ones throughout, fitting a shielded power cord in the process.

The plinth of an original deck has to be cleaned and then polished with plenty of beeswax and elbow grease. This effort pays off handsomely in the overall appearance of the restored/refurbished machine. And this is, more or less, all I think that ought to be allowed to be done to old turntables in original condition. Let's talk tweaks now.

For the tonearms, I'm afraid that I have some strange personal opinions. To begin with, I do not like SMEs very much. The new ones must be good, but are they're awfully expensive and I do not like their style. The classic 3009/3012 series is good-looking, well-engineered, and perennially fashionable, but I do not believe that they are exceptional. Also, the fixed-headshell models will give you nightmares when it's time for cartridge changes.

Over the years, I've fitted almost every-

thing else besides SMEs on my several '125s', from a Mayware MkIV to a Dynavector '505' and Stax or a Rabco 'SL-8'. Having developed a soft spot for Grace tonearms, I've tried also the '545', '840F' (such an elegant design!), '704', 747', finally settling as of today on a '707 MkII' mounted on a special, custom-made armboard. The Dynavector '505' works wonders, but only with a 124 on a heavy plinth. Also, it's quite tricky to use (no lift, etc). I understand that the '507' is easier.

The design of the armboard itself is more important than most people would think, at least in the '125'. For a while, people designed and cut their own armboards from wood, Perspex, even glass and cheap plastics. This will give the arm a place to be bolted onto, but often nothing more than that. A good armboard is a *must*, otherwise the purpose of providing the deck with a solid 18 kilogram plinth will be negated.

This is especially true for the '125', where the armboard is supported by those three metal 'fingers', but it's not fixed around its perimeter. This can spoil its overall rigidity and cause some subtle resonance around the 'free' edges (i.e., the three sides not adjacent to the metal chassis).

I've experimented quite a bit with boards, inventing for myself a 'code' to identify at a glance the armboard I'm using: matte black is the original 'factory' board, light-grey is a reproduction in some different wood or even plastic, light green is for 'fancy' boards. My '707' is now installed on a wafer of two slices of oak sandwiching a 3 mm foil of soft Neoprene (rubber). The three layers are glued together, Ideally, this construction should help to kill the board's unwanted resonance and it appears to work quite well.

I've never tried an all-metal armboard, simply because it's complicated to arrange for someone to cut them from sheet aluminium or copper. I wouldn't use steel or iron for fear of magnetic trouble! I'm not sure that, in the end, a metal armboard wouldn't ring like a bell. I plan to experiment with a glass-plastic sandwich sometime soon.

One thing that I always do with a '125 if I'll use it for playing records in earnest, is to remove the bottom panel. This flimsy wooden sheet is a sort of 'dust cover', but it creates a closed 'box' that I don't like, since it can introduce an undesired 'boominess'. I feel it's better to get rid of it pronto. An added benefit of removal is easy access to the knurled knobs of the suspension, making the levelling of the unit much simpler and easier.

Since the chassis/subchassis assembly of the '125' is clearly decoupled, I feel no great urge to put conical points underneath. I use rubber supports, and they work great with the stock plinth. I will report that I once tried to screw a 'bare' '125' to a very heavy wooden plinth and the sound didn't change a bit. I'd guess that the springs of the counterchassis insulate it so well that you don't really need to provide a better plinth, and the belt absorbs most of the very few vibrations produced by the tiny motor of the '125'. I've tried to put some damping material (Neoprene, sponge, even hard rubber) in the springs to dampen their floating, but the results weren't very good. At the end, this only introduced some sensitivity to acoustic feedback.

Of course, this way of thinking doesn't apply to the '124', which absolutely needs a heavy, sturdy plinth because of its powerful motor and idler-wheel drive. I like to mount a '124' on a very heavy, high-density ply base, taking care to screw the chassis firmly to the plinth from underneath, using the four support screws, the ones carrying the height-adjusting nuts as retaining bolts, for four nuts and washers. Between the chassis and the plinth I like to put only four grommets of hard rubber. Some would probably prefer a harder material, hardwood or maybe even metal (I never tried it). With a final mass of over 20 kilograms for a typical plinth, I feel that you do not need cones, but if you were to fit a good quartet of brass points, surely they wouldn't harm the sound a bit.

Some like to fit 16" arms to the '124' and special power supplies. You can, of course, but the small amount of vibration that an idler-wheel deck can produce would be amplified by such a long arm, whilst a high-grade shielded AC cord will solve 90% of the problems related to the '124' and '125' power supply. You have to try to believe.

I stop with the power cord upgrade and use a fairly high-mass arm for the '124', like the excellent stock 'TP-14' or the reliable Audio Technica 'ATP-12', an old favourite. On the '125' I use lower-mass tonearms, like the '707 MkII' I mentioned before, but I do not despise the 'TP-16' arm, a good, medium-mass design that is easy to set up and use with almost any type of cartridge.

I also found the Mayware 'MkIV' to be well suited to the '125', at least with the Denon '103' I routinely use as a benchmark cartridge for the various decks I'm working on. As a footnote, I would like to say that whilst I always try to extract something more from my 'hot-rod' '125' and '124', I've never messed with my EMT '928'. like its bigger brothers, it is way too well-made and engineered to risk to spoiling it with some goofy ideas and clumsy workmanship. EMTs are somewhat intimidating, probably having something to do with the astronomic prices of their spare parts!

My constantly-tweaked, first-series '125' (no clutch) is somehow the 'moral flagship' of my collection, as it's the only Thorens normally listened to. The older decks are used in turns to keep them moving, but few of them sound as good as I'd like. As for the '124', I have a 'MkII' that I'm perennially working on...waiting for a new plinth now,in fact.

I have another beautiful, completely original '124 MkII' on display. This one is towering above the other decks in the middle of my turntable collection, and I think that it deserves this commanding position, standing proud in its original battleship-grey livery amongst the other machines of my small but dedicated collection, surrounded by lesser but always worthy Thorens and surveying from a vantage position the day-to-day work of the EMTs. I'm sure that Herr Thorens and Herr Franz would be proud of this layout.

THORENS

Produktionsdaten der Thorens-Plattenspieler

Type	Year	Type	Year
TD 104	1978-1981	TD 166 VI	1992-
TD 104 II	1980-1984	TD 180	1990-
TD 105	1978-1981	TD 184	1958-1962
TD 105 II	1981-1984	TD 224	1962-1968
TD 110	1977-1982	TD 226	1981-1986
TD 115	1977-1982	TD 230	1986-1988
TD 115 II	1982-1984	TD 230 Excl.	1988-1992
TD 124	1957-1965	TD 230 II	1988-1990
TD 124 II	1966-1968	TD 230 III	1991-1991
TD 125	1968-1971	TD 250 IV	1992-
TD 125 II	1972-1975	TD 290	1991-
TD 126	1976-1976	TD 316	1985-1988
TD 126 II	1976-1977	TD 316 II	1988-1991
TD 126 III	1977-1986	TD 316 III	1992-
TD 127	1983-1984	TD 318	1985-1988
TD 134	1959-1964	TD 318 II	1988-1991
TD 135	1961-1964	TD 318 III	1992-
TD 135 II	1965-1968	TD 320 TP 16 III	1984-1986
TD 145	1975-1976	TD 320 TP 16 IV	1986-1988
TD 145 II	1976-1978	TD 320 II	1988-1991
TD 146	1983-1986	TD 320 III	1992-
TD 146 II	1986-1987	TD 321	1985-1988
TD 146 V	1988-1991	TD 321 II	1988-1991
TD 146 VI	1992-	TD 520	1986-1989
TD 147	1982-1985	TD 520 II	1989-1992
TD 147 Jubilee	1983-1985	TD 521	1986-1992
TD 150	1965-1968	TD 524	1983-
TD 150 II	1969-1973	TD 535	1988-1991
TD 160	1972-1976	TD 2001	1989-
TD 160 II	1976-1984	TD 3001	1990-
TD 160 IV	1987-1988	Ambiance	1988-1990
TD 160 V	1988-	Concrete	1988-1992
TD 165	1972-1976	Phantasie	1986-1988
TD 166	1975-1976	Prestige	1983-
TD 166 II	1976-1987	Reference	1980-1981
TD 166 V	1988-1991		

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Friends:

I am currently looking for any data, schemes, history, production figures, i.e. almost anything about the Telefunken professional turntables, like the PS 81 idler-wheel decks I've just bought and its successor, the direct-drive PS 81 DD.

StefanoPasini
stefpas@tin.it

Siemens/Klangfilm Postwar Cinema Amplifiers (W-Germany and Austria)

by Dipl. Ing. H. Jakobi, Sulzbach, Germany

The name "Klangfilm"stands for Siemens' famous cinema/theater range. Klangfilm directly translated means "the sound of cinema" or the "sound of the film". Siemens produced some of the most sought after power amplifiers and speakers, as well as some remarkable preamplifiers and mixers.

Made in W-Germany were the models: KL-401, KL-402a, KL-403a, KL-502a, KL-408a, KL-203/4 and the KL-V-410. There are other models, but they are ELA amps, using only 100 ohms output transformers and so not useful for the average audio enthusiast.

Made in Austria is the model KL-5418, there might be more Austrian models but in more than fifteen years research,this is the only one I came across, and I could not find any literature on this model.

Klangfilm used only three power tubes, the EF-12 (just after the war, which is a small version of the EL-156, and sounds very smooth and beautiful, if made by Telefunken); the German professional F2a11, and later the EL-34. The driver tubes were the EF-12, an early version of the famous EF-804 (very similar to the EF-86, but far superior); later the ECC-40, an early version of the ECC-82 (12AU7) and then the ECC-83. Rectifiers were the EZ-12 and ,later, the GZ-34.

All amplifiers were designed for cinema use, which means that the ultra-sensitive inputs should not be used for home audio It is a shame that one cannot make use of the outstanding input transformers, but... they can be used for other designs! Most users just connect the input to the grid of the 2nd, or if less gain is needed, even to the grid of the 3rd of the drivers. An input resistor in the region of 1 Kohms in series to the grid and a 100-220 picofarad C will be all that is needed to suppress high frequency disturbances or oscillation.

With some luck one might find an old pair of matching input transformers and to use for balanced input. But beware, it is better stick with the simple "grid" entry, instead of using a bad transformer.

The heart of these amplifiers are their outstanding output transformers, which nobody can wind anymore with this quality. All parts are first class, it is not recommended to modify too much, and most of the electrolytic condensers will work for many years. In the early KL-401a only paper-in-oil condensers are used. These sadly can dry out, and it is recommended to replace them with similar types.

The build quality is typical W-German, Mercedes like, long lasting and precision mechanics, best parts quality: Siemens ceramic insulated silver foil coupling-C's (!!!), MP or paper-in-oil C's, etc., will be found as a standard! Tube rectification with highest quality chokes is standard, the power transformers are oversized, use the best materials and are usually 110/120/220/240 volts, 50/60 Hz.

All tubes can still be found easily, only the F2a11 is expensive, but then it is a professional long life tube and shall last at least 8000 hours, if matched pairs are used. Very important: do not use cheap EL-34's! Only original Telefunkens, Valvo's (which are also sold under Philips, Miniwatt, Siemens, Amperex, and yes... also the famous Mullard was made by Philips Valvo in Holland!) must be used for full potential. Do not use the E-German EL-12 (also EL-12N) made by Hoges, it is inferior! The best is the Telefunken, the stronger EL-12/325 and EL-12/375 can take higher plate voltages and are suited as well.

As the F2a11 (and the F2a, which just has a different base) are such extraordinary pentodes, which cannot be found elsewhere, I decided to have the data here as well:

Type	Longlife prof.Tetrode
Filament	6.3V/2A
(indirectly heated)	
Platevolt.	250V
Platecurrent	97 mA
Max platevolt	425V
(some books suggest 600V max.!)	
Gridvolt	250V (max. 425V)
Neg. gridvolt	-19V
Platedissip.	30W

The way this tetrode is built makes it perfect for triode configurations. It sounds extremely natural if applied correctly, even in a non-triode circuit!

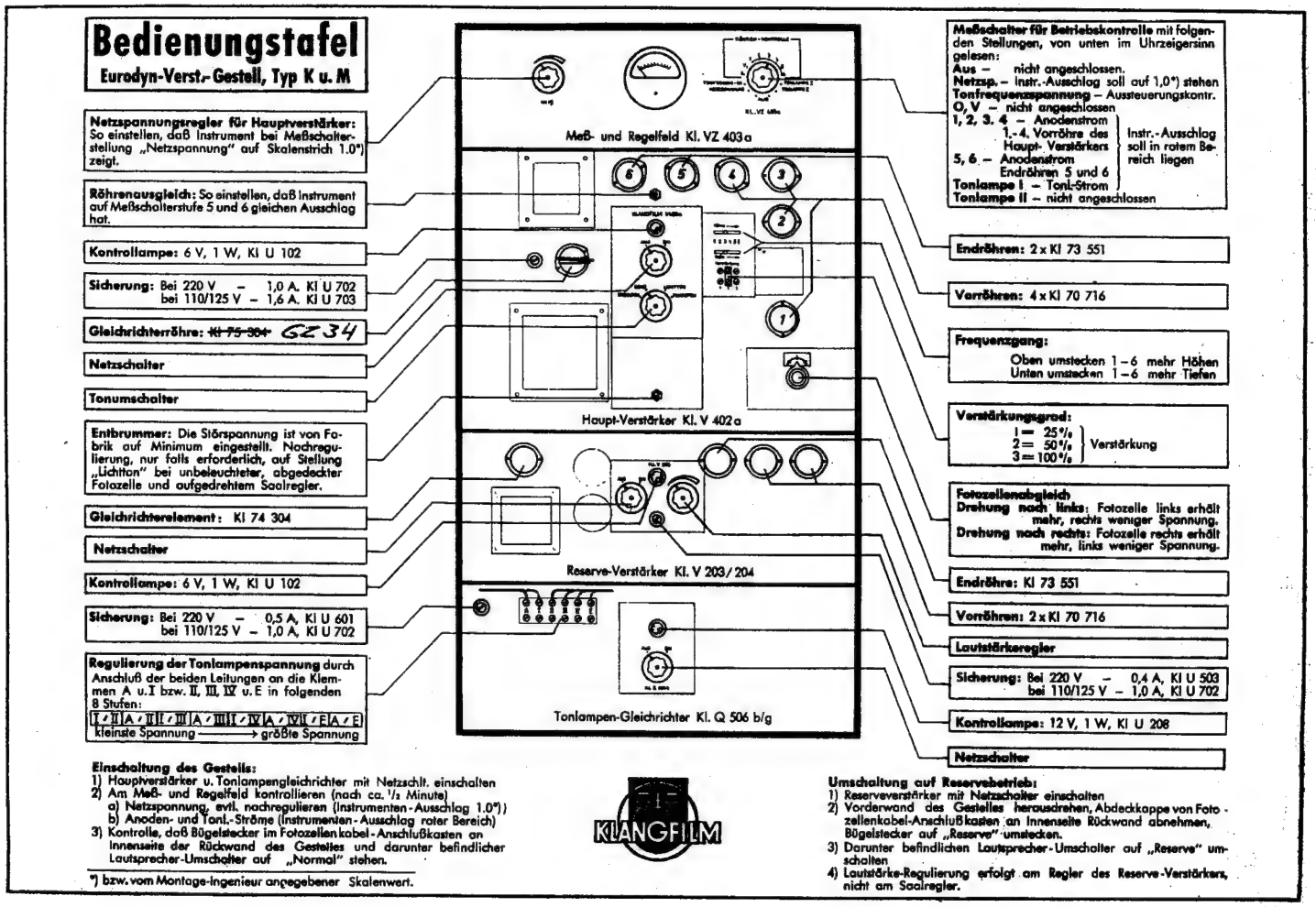
IMPORTANT: Klangfilm used a Klangfilm code for most of their tubes, starting with a KL like for the other units. For the postwar amps we have the most important codes: (prewar codes will be shown in part II!)

KL-70715 = EF-12
KL-70716 = EF-12k
(k stands for "klirrarm"= low noise)
KL-73550 = EF-12
KL-73551 = F2a11
KL-76303 = RGN 2504

Tubes used in the later models like the EF-40, ECC-83, EL-34, GZ-34 have no KL code!

The KL-401a: This unit is made with a cast frame and is very heavy (about 60 lbs.). Four EF-12's are used, and a special tone control unit (volume, bass and treble) can be plugged into the circuit between the input tube and the 3rd stage (not advised for best performance). Without the tone control unit it is easiest to use the grid of the 3rd EF-12 as the input (V-3). The rectification is done with the EZ-12, a very common rectifier used in German studio and cinema technique, and in early models with the RGN-2504, which is in its mesh plate versions together with the RGN-2004 the very best rectifier I ever heard.

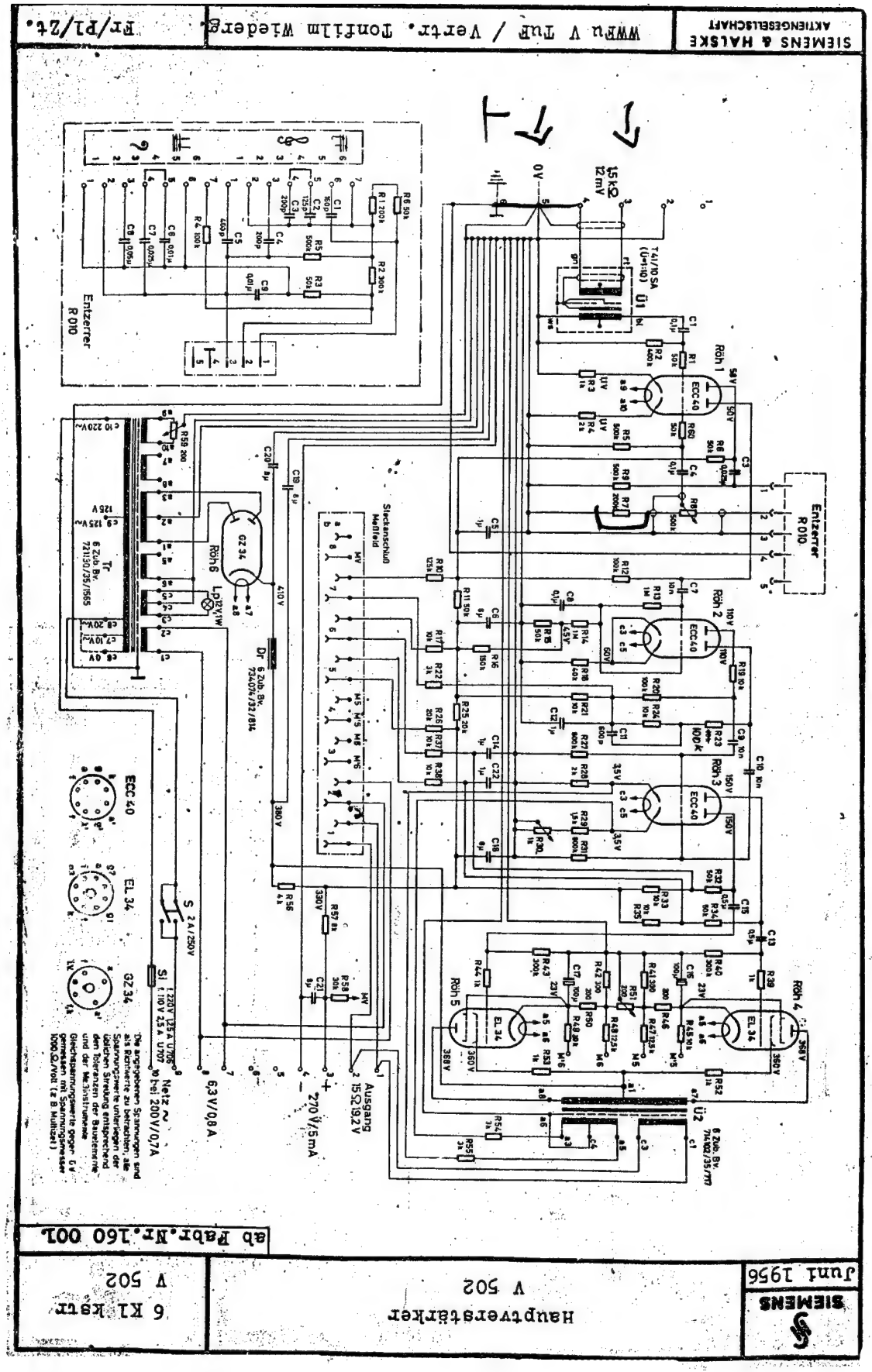
We find paper-in-oil condensers throughout the whole circuit and a wonderful output transformer with 15 ohms and 200 ohms. 200 ohms were not needed for ELA speakers, but for some special Siemens speakers which will be introduced in a later part. The EF-12/375's in the PP output stage are triode connected (without the usual 100 ohms resistor, the screen grid is directly connected to the plate!)



The KL-402a and 403a (identical): These amps are nearly the same in circuitry as the 401a, but use precision welded galvanized steel sheets in the case and are 19" rack-mount (like all amps built after the 401's). Instead of the EZ-12 the GZ-34 is used as a rectifier and a better tone control unit is used (if needed). MP-condensers replace the paper-in-oils (and are still better than all MKP's or electrolytic C's!) and we find Siemens silver foil coupling C's. I compared this amp with the famous Marantz 9's. The KL-403's outperformed the Marantz with ease! I am not kidding! Even the KL-502a,after modified to triode connection of its EL-34's did.The KL-403 is on the same level as the famous WE-86, and this means something as it does not use 300B's. It is as dynamic and immediate, a little less euphonic and with more clarity and speed. A fantastic amp. And built to last forever. And... the price is about 40% of the Marantz Model 9).

The KL-502a: This amp uses the well-known EL-34 and is in my ears the very best EL-34 amp ever built, if triode connected (connect each screen grid of each EL-34 via 100 ohms on the plate and only use "real" EL-34's as mentioned before). It outperformed the Marantz 9 with ease, and is very close in its sonic signature to the KL-403a. The driver/input tubes are





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		C20		
1	Metallpapierkondensator	C21	8	uF
1	"	C22	8	uF
1	"	C23	0,25	uF
1	"	C24	0,25	uF
1	"	C25	16	uF
1	"	C26	16	uF
		C27		
1	Metallpapierkondensator	C28	0,25	uF
1	"	C29	8	uF
1	"	C30	8	uF
1	"	C31	8	uF
1	Entzerrer komplett		Kl. V 402 a Tz. 3	
1	Netztransformator	Tr1	Kf.Bv. 2509/00	
1	Eingangsübertrager	Ue1	Kl. U 060	
1	Ausgangsübertrager	Ue2	Kf.Bv. 2306/30	
1	Drossel	Dr	Funk.Bv. 2404/	
1	Signallampe	S1	6 V, 1 W, Kl. U 102	
1	Schalter	S 1		
1	Schalter	S 2		
1	Sicherung	S1	1,0 A, Kl. U 702	
1	Sicherung (Beipack)	S1	1,6 A, Kl. U 702	

1	Schichtwiderstand	R44	100	KOhm
1	"	R45	100	KOhm
1	Drahtwiderstand	R46	300	Ohm
1	"	R47	300	Ohm
1	Drahtdrehwiderstand	R48	200	Ohm
1	Schichtwiderstand	R49	5	KOhm
1	"	R50	5	KOhm
1	Drahtwiderstand	R51	180	Ohm
1	"	R52	180	Ohm
1	Schichtwiderstand	R53	10	KOhm
1	"	R54	10	KOhm
1	"	R55	10	KOhm
1	"	R56	10	KOhm
1	"	R57	50	KOhm
1	"	R58	5	KOhm
1	Drahtdrehwiderstand	R59	200	Ohm
1	Schichtwiderstand	R60	100	Ohm
1	"	R61	100	Ohm
1	Papierkondensator	C1	0,025	uF
1	"	C 2	0,025	uF
1	Metallpapierkondensator	C 3	1	uF
1	"	C 4	1	uF
1	"	C 5	1	uF
1	"	C 6	0,25	uF
1	"	C 7	8	uF
1	Keramik-Kondensator	C 8	100	pF
1	Metallpapierkondensator	C 9	1	uF
1	"	C10	2	uF
		C11		
1	Papierkondensator	C12	0,025	uF
1	Metallpapierkondensator	C13	8	uF
1	"	C14	1	uF
1	"	C15	8	uF
1	"	C16	1	uF
1	"	C17	8	uF
1	"	C18	1	uF
1	"	C19	0,25	uF

1	Schichtwiderstand	R 1	1	KOhm
1	"	R 2	2	KOhm
1	"	R 3	1	KOhm
1	"	R 4	1	KOhm
1	"	R 5	2	KOhm
1	"	R 6	1	KOhm
1	"	R 7	2	KOhm
1	"	R 8	2	KOhm
1	"	R 9	250	KOhm
1	"	R10	1	KOhm
1	"	R11	100	KOhm
1	"	R12	500	KOhm
1	Schichtdrahtwiderstand	R13	500	KOhm
1	Schichtwiderstand	R14	30	KOhm
1	"	R15	100	KOhm
1	"	R16	2	KOhm
1	"	R17	30	KOhm
1	"	R18	50	KOhm
1	"	R19	60	KOhm
1	"	R20	50	KOhm
1	"	R21	50	KOhm
1	"	R22	100	KOhm
1	"	R23	1	KOhm
1	"	R24	500	KOhm
1	"	R25	150	KOhm
1	"	R26	50	KOhm
1	"	R27	20	KOhm
1	"	R28	10	KOhm
1	"	R29	2	KOhm
1	"	R30	400	Ohm
1	"	R31	50	KOhm
1	"	R32	300	KOhm
1	"	R33	100	KOhm
1	"	R34	50	KOhm
1	"	R35	60	KOhm
1	"	R36	40	KOhm
1	"	R37	20	KOhm
1	"	R38	2	KOhm
1	"	R39	20	KOhm
1	"	R40	20	KOhm
1	"	R41	20	KOhm
1	"	R42	100	KOhm
1	"	R43	100	KOhm

Stückzahl	Benennung	Teil	Zeichng. Norm	Bemerkung

Nr.	Art der Änderung	Tag	Name	Nr.	Art der Änderung	Tag	Name

	Datum	Name
Konstr.	13.	4.51
Geprüft		
Normgepr.		

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Klangfilm G. m. b. H.

Klangfilm G. m. b. H.

Stückliste
für
Verstärker
Nicht für die Fabrikation ! (2 Blätter)

Kl. V 402 a Blatt 1

Ersatz für:
Ersetzt durch:

Stückzahl	Benennung	Teil	Zeichng. Norm	Bemerkung
1	Schichtwiderstand	R 1	100 K Ohm	
1	"	R 2	50 K Ohm	
1	"	R 3	50 K Ohm	
1	"	R 4	200 K Ohm	
1	"	R 5	500 K Ohm	
1	"	R 6	100 K Ohm	
1	"	R 7	200 K Ohm	
1	"	R 8	300 K Ohm	
1	"	R 9	1 M Ohm	
1	Papierkondensator	C 1	0,02 uF 250	
1	"	C 2	0,02 uF 250	
1	"	C 3	2500 pF 250	
1	Kunstfolien-Kondensator	C 4	150 pF 250	
1	"	C 5	300 pF 250	
1	"	C 6	100 pF 250	
1	Kunstfolien-Kondensator	C 7	250 pF 250	

Nr.	Art der Änderung	Tag	Name	Nr.	Art der Änderung	Tag	Name

	Datum	Name
Konstr.	28.5	1951
Geprüft		
Normgepr.		

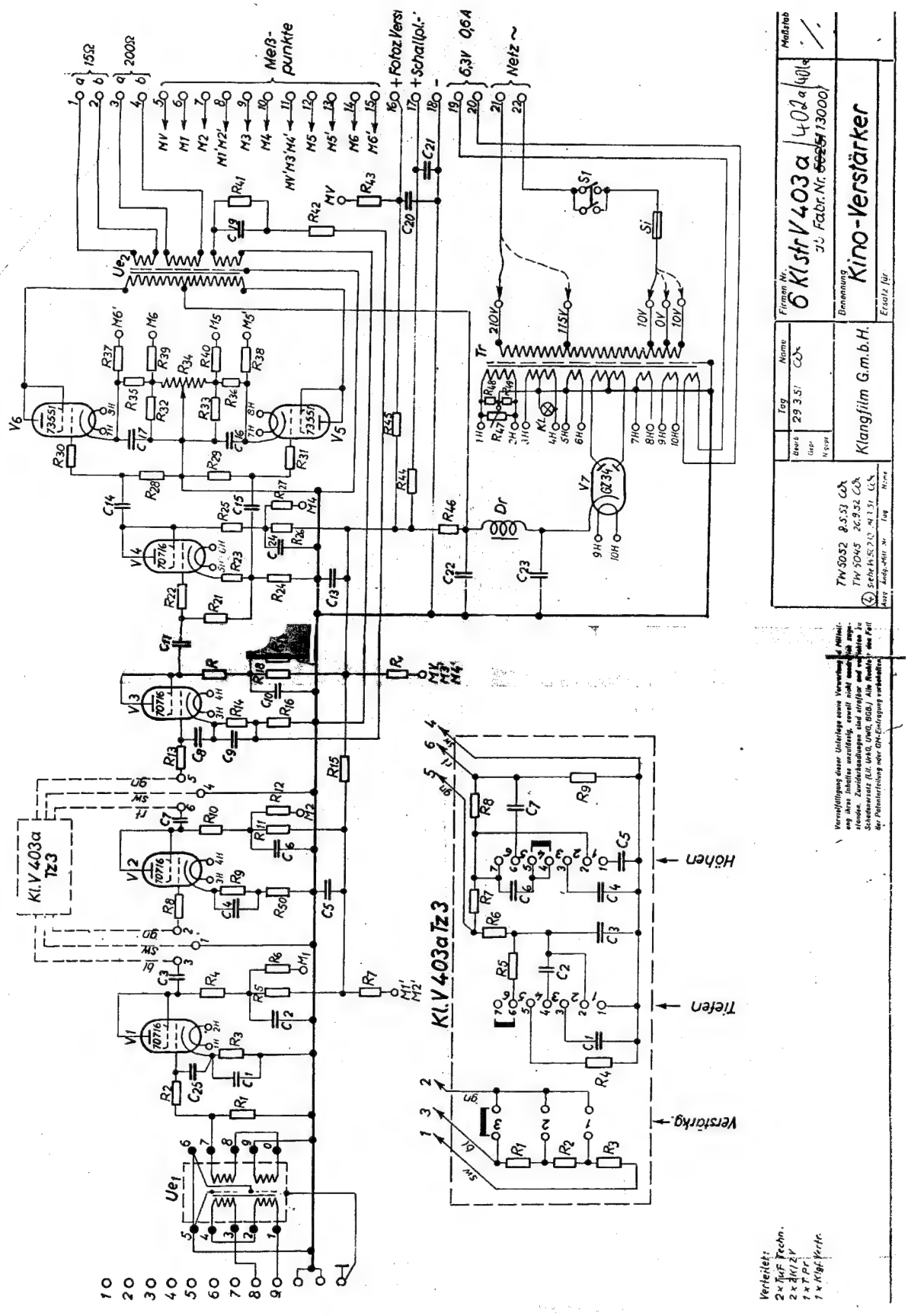
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Klangfilm G. m. b. H.

Klangfilm G. m. b. H.

Stückliste
zum
Entzerrerkasten
(s.Kl.V 402a/403a/pri)
Nicht für die Fabrikation!

Kl. V 403 a Tz.3

Ersatz für:
Ersetzt durch:


Kl.V403a Tz3
Kl.V403a Tz3
Höhen
Tiefen
Verstärkg.
Ue1
Ue2
Tr
Dr
Kino-Verstärker
Klangfilm G.m.b.H.
6 Kl.str V 403a
Netz ~
6,3V 0,6A
+ Schallpl.-
+ Fotoz. Vers
Meß-punkte

the ECC-40's (3) the rectifier is the GZ-34. Best parts are used as in the KL-403.

The KL-408a: This was an amplifier built for smaller cinemas, and it is not on par with the models mentioned before, which does not mean that it does not sound good. It sounds pretty close to the Marantz Model 8b, and it is a matter of taste (as always) which one sounds better. There are two inputs which can be used, a 500 Kohms unbalanced and a balanced 3 Kohms using a very good permalloy input transformer. Again, this amp sounds best when the EL-34's are triode connected as described before. Sadly the C's in the PS are electrolytic types, but at least of good Siemens or Bosch quality. Check them and if you can, replace with MP's. The rectifier is again the GZ-34. Build quality is otherwise on the same level as the others.

Now we come to the most sought after KL-amps, the KL-203/204 and the later KL-V-410 amps, which are so called "Reserve Verstarker" which means amps for emergency. Well, they are by no means cheaply built amps, only the power output is low, as they are single ended pentode amps (F2a11 SE) and produce therefore only about 7 watts, but they are very, very clean watts. But these amps are overrated! They are not on the same level as the others with the exception of the KL-408a, which are outperformed with more attack, clarity and "being there", which is typical for single ended designs.

We finish Part I with the KL-5418, which was made by the Austrian branch of Siemens (called Klangfilm there as well). This branch produced some very remarkable units, for example the late "Ed" tube was made there (a famous European triode, the industrial version of the AD-1!) as well as an ultra rare speaker called the Klangfilm "Euronette", a full range wooden/textile tractrix horn (not to be mixed up with the prewar "Euronette" power amp).

This amp uses again EL-34's (ultralinear) and triode connected it sounds as good as the KL-502a. It uses a rare rectifier called the Z2c, which is again an industrial tube like the Ed, is totally different in its design approach to the German power amps. Most parts are Austrian made, and it is necessary to change all the orange coloured 100 uF electrolytic C's as they are prone to be dried out.

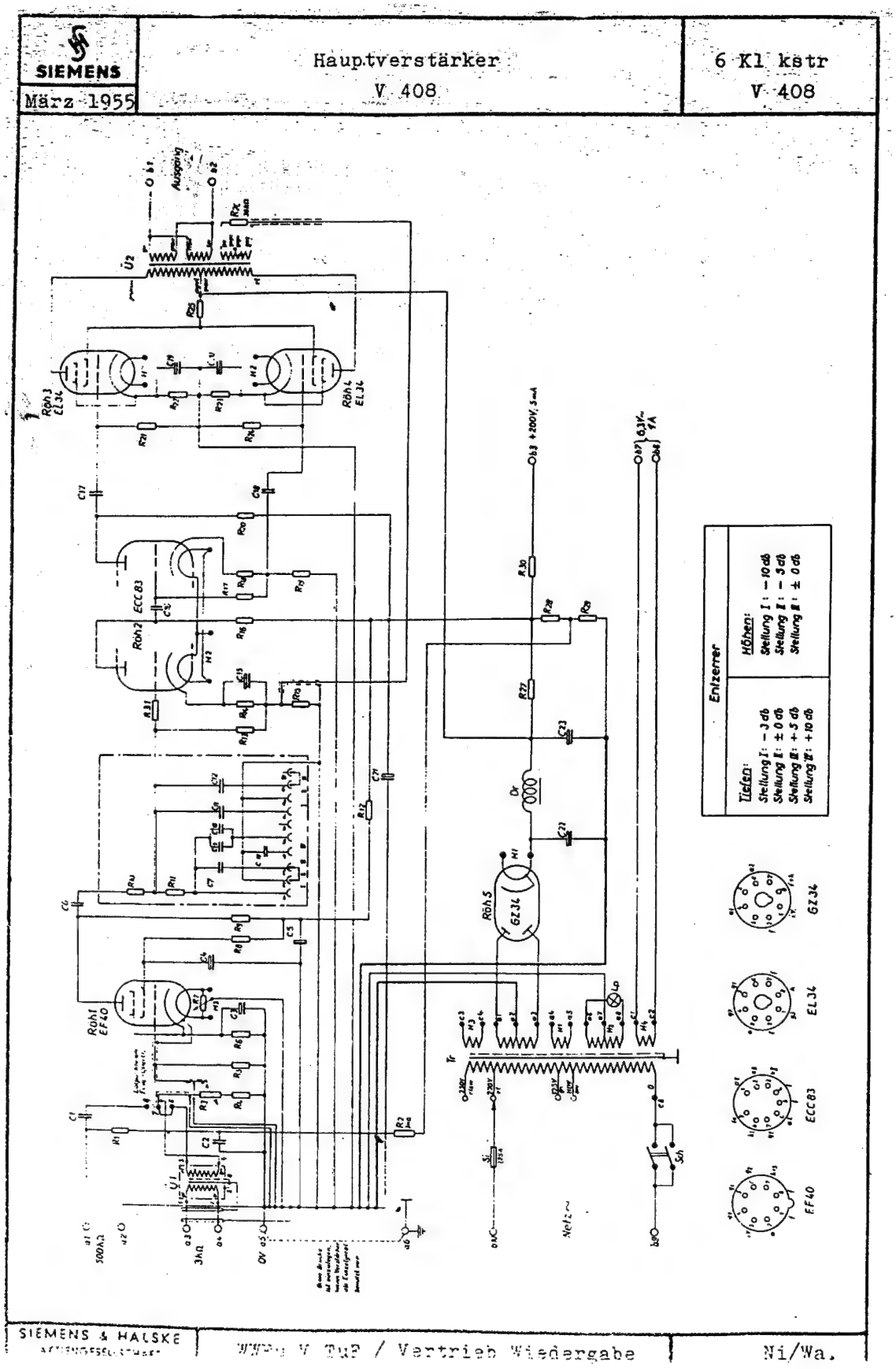


Austrian-made Kl-5418— Shown without rectifier above

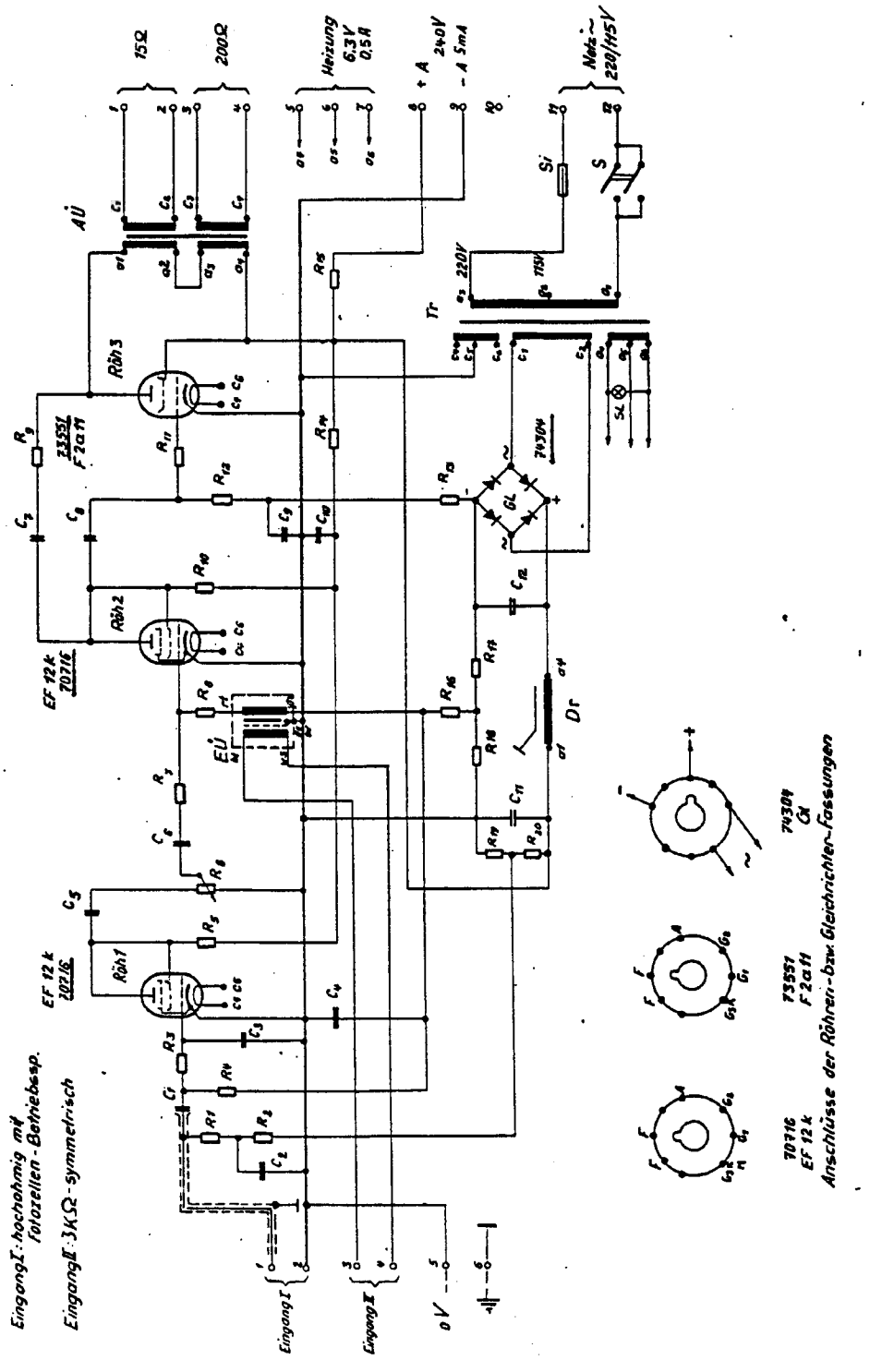




KL-401a — shown without tubes


SIEMENS
März 1955
Hauptverstärker
V 408
6 Kl kstr
V 408
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Ausgang
Röh3 EL34
Röh4 EL34
Röh2 ECC83
Röh1 EF40
Röh5 GZ34
Entzerrer
Tiefen:
Stellung I: – 3 db
Stellung II: ± 0 db
Stellung III: + 5 db
Stellung IV: + 10 db
Höhen:
Stellung I: – 10 db
Stellung II: – 5 db
Stellung III: ± 0 db
GZ34
EL34
ECC83
EF40
SIEMENS & HALSKE
Ni/Wa.

SIEMENS August 1954	Reserve-Verstärker V 204 a	6 Xl kstr V 204 a



SIEMENS & HALSKE AKTIENGESELLSCHAFT	WVR WA G Vertrieb Klangfilm	Fr/Sn.

SIEMENS Aug.1954	Reserve-Verstärker V 204 a	6 Kl ksk V 204 a

R 1	Schichtwiderstand	100 kOhm	
R 2	Schichtwiderstand	3 MOhm	
R 3	Schichtwiderstand	100 kOhm	
R 4	Schichtwiderstand	1 MOhm	
R 5	Schichtwiderstand	150 kOhm	
R 6	Schichtdrehwiderstand	500 kOhm	pos.log.
R 7	Schichtwiderstand	500 kOhm	
R 8	Schichtwideratand	150 kOhm	
R 9	Schichtwiderstand	500 kOhm	
R 10	Schichtwiderstand	100 kOhm	
R 11	Schichtwiderstand	1 kOhm	
R 12	Schichtwiderstand	200 kOhm	
R 13	Schichtwiderstand	100 kOhm	
R 14	Schichtwiderstand	50 kOhm	
R 15	Schichtwiderstand	2 kOhm	
R 16	Schichtwiderstand	1 MOhm	
R 17	Schichtwiderstand	60 Ohm	
R 18	Schichtwiderstand	30 Ohm	
R 19	Schichtwiderstand	150 kOhm	
R 20	Schichtwiderstand	125 kOhm	

C 1	Kondensator	5000 pF	
C 2	MP-Kondensator	2 µF	
C 3	Keramik-Kondensator	50 pF	
C 4	MP-Kondensator	2 µF	
C 5	Kondensator	0,01 µF	
C 6	Kondensator	0,01 µF	
C 7	Kondensator	1000 pF	
C 8	Kondensator	20000 pF	
C 9	MP-Kondensator	1 µF	
C 10	MP-Kondensator	1 µF	
C 11	MP-Kondensator	16 µF	
C 12	MP-Kondensator	16 µF	

Tr	Netztransformator		
Dr	Siebdrossel		
AÜ	Ausgangsübertrager		
EÜ	Eingangsübertrager		
S	Netzschalter		
Si	Sicherung (für 220 V)	0,5 A	Kl U 601
	Sicherung (für 115 V, im Beipack)	1 A	Kl U 702
Sl	Signallampe	12 V/ 1 W	Kl U 705

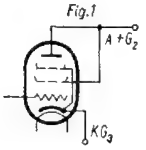
Röh 1	Röhre EF 12 k	Kl 70716
Röh 2	Röhre EF 12 k	Kl 70716
Röh 3	Röhre F 2a 11	Kl 73551
GL	Steckgleichrichter	Kl 74304

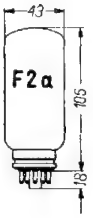
SIEMENS & HALSKE AKTIENGESELLSCHAFT	WWR WA G Vertrieb Klangfilm	Pl/Schl.

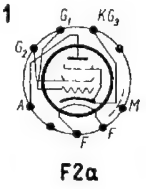
T.			U_f V	I_f A	Cl.	U_a V	U_{g2} V	$U_{b(g2)}$ V	R_{g1} kΩ	U_{g1} V	I_a mA	I_{g2} mA	S mA/V	R_i kΩ	R_k Ω	R_o kΩ	P_o W	$U_{g1\sim}$ V	h %	P_{g2} W	P_a W
F 2 a F 2 a 11	Siem Siem	1 2	6,3 6,3	2 2	A	250	250			— 7	95÷97	14÷20			60	2,2	10	4,6	10		
					stat	425	425			—19	60	10	14	25	290						
					AB	250	250				114÷128	16÷32			140	5	20	7,3	4		
						330		330	1		136÷160	20÷33			160	5	32	10,5	4		
						425		425	3		120÷154	18÷30			250	6	40	16	5		
					B	250	250			—11	60÷140	9÷32				4	20	7,4	2,5		
						330		330	1	—15	76÷160	11÷33				5	32	10,2	3		
						425		425	3	—22	50÷160	8÷31				6	40	15	2,5		
						425		425	1,5	—22	56÷190	9÷40				5	50	15	4		
					A	330	Fig. 1			—13	90÷94	(μ = 17)	22	0,8	140	1,5	5,5	9	10		
					AB	250	—				100÷108	—			200	3	6	7,5	7		
					Fig. 1	330	—				140÷152	—			200	3	12	10,3	1,5		
						425	—				130÷146	—			300	5	20	15,2	2,5		
						425	425			maximum (I_k = 140 mA; R_{g1} = 0,5 MΩ; $U_{f/k}$ = 80 V)										5	30

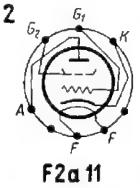
[1]) vide * 4

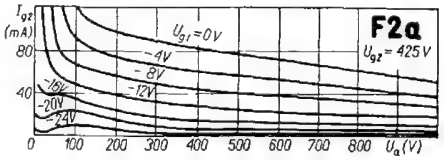
C_{g1} pF	C_a pF	$C_{g1/a}$ pF	
20,5	13	0,45	pentod.
14	15,5	7	triod.

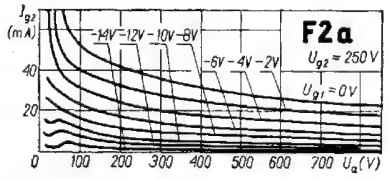


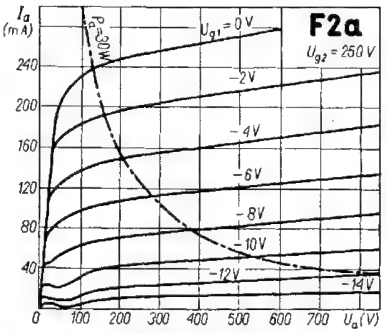


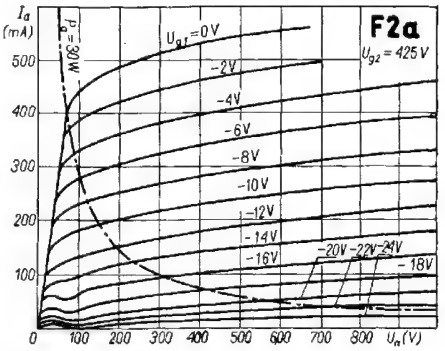




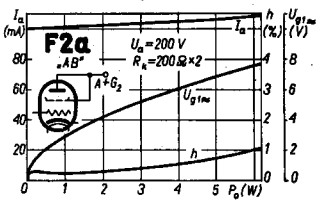


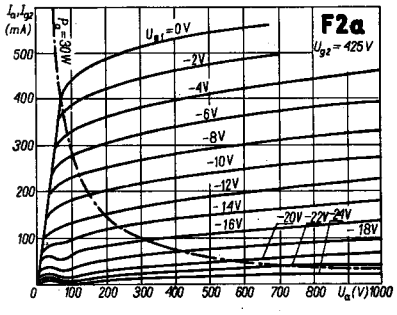


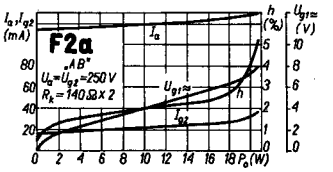


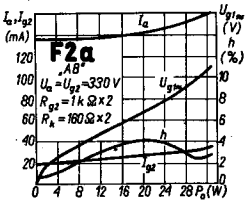


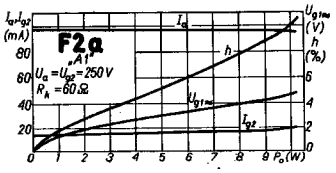


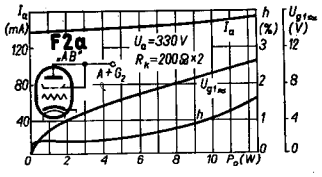




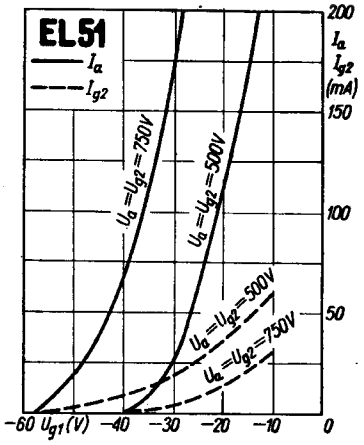


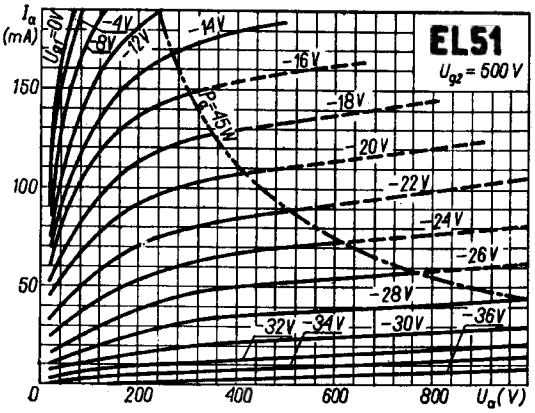


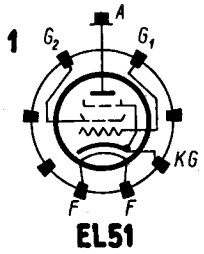


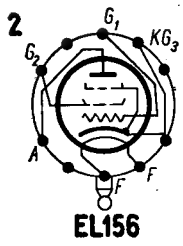


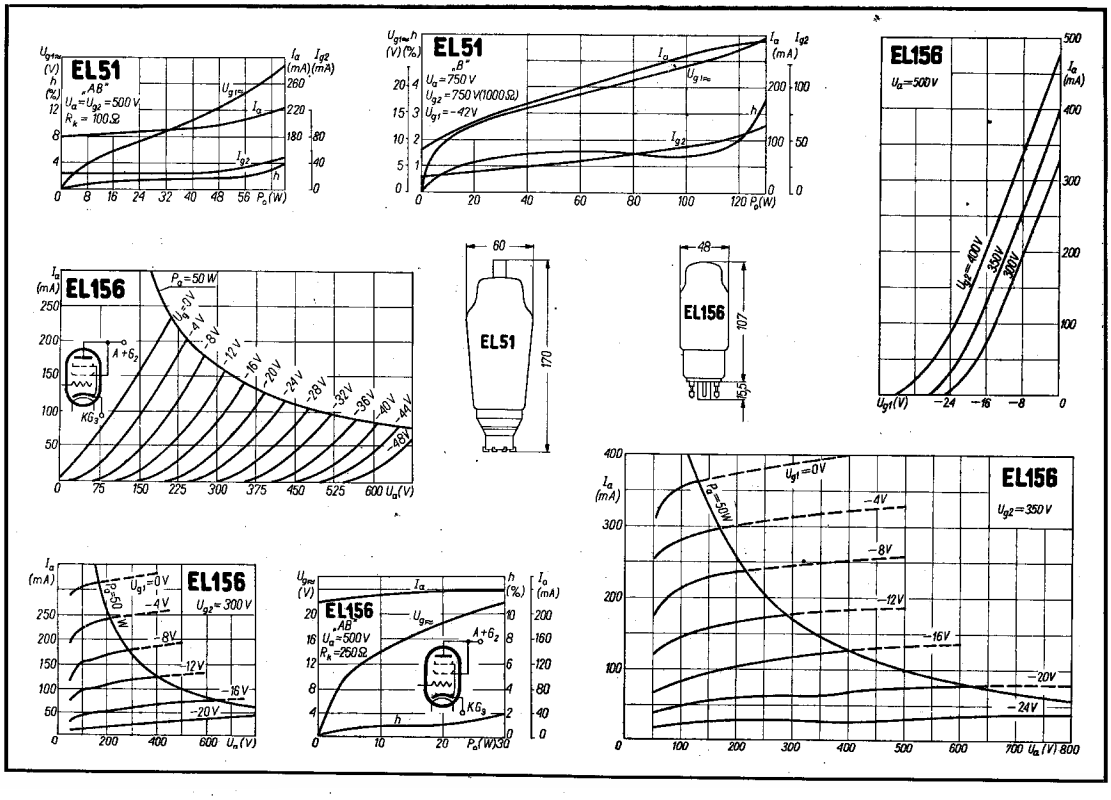
T.			U_f V	I_f A	Cl.	U_a V	U_{g2} V	U_{g1} V	I_a mA	I_{g2} mA	S mA/V	R_i kΩ	μ g_2/g_1 (a/g)	R_k Ω	R_o kΩ	P_o W	$U_{g1\approx}$ V	h %
EL 51	eur	1	6,3	1,9	stat.	500	500	− 22	95	12	11	33	16					
					stat.	750	750	− 42	40	6	7	55	16					
					AB	500	500		(95÷115)×2	(12,5÷30)×2				100	4,8	70	20	6
					B	750	<750	− 42	(40÷150)×2	(6÷35)×2		(R_{g2} = 1000 Ω)			6	125	29	7
						750	750		maximum (I_k = 200 mA; P_a = 45 W; P_{g2} = 7 W; R_{g1}=0,7 MΩ; $U_{f/k}$ = 50 V)									
EL 151	Tlf	2	6,3	1,9	stat.	400	400	− 36	75	7								
					AB	450	450	− 24	117×2	20×2				200	2,8	90	19	
						800	450		maximum (P_a = 60 W; P_{g2} = 5 W; R_{g1} = 0,1 MΩ)									
EL 156	Tlf	2	6,3	1,9	stat.	800	300		55÷65		10	25	13					
					A 1	350	250		120÷116	15÷24				60	4	15	6	8
					A 1	450	280		112÷108	17÷27				90	3,8	25	9,2	9
					AB	600	300		(80÷ 95)×2	(10÷18)×2				160	8,5	65	13,5	4
					AB	600	350		(80÷100)×2	(10,5÷24)×2				200	7,6	80	18,5	4
					B	800	300	− 20	(45÷100)×2	(4,5÷20)×2					11	105	15	5
					B	800	350	− 24	(45÷120)×2	(5÷25)×2					9,5	130	18	6
					stat.	350	—	− 16	140	—	12,5	0,8	(12)	(Fig.1)				
					AB	500	—		(110÷120)×2	—	(Fig.1)			250	2,8	30	22	2
						800			maximum (I_k = 180 mA; P_a = 50 W; P_{g2} = 8 W; R_{g1} = 0,1 MΩ; $U_{f/k}$ = 50 V)									











WHUPPIN BUTT with TRIODES Round Two



by Joe Roberts

Still wrestling with the hardware...

Looking back over recent tube audio history, one would have to say that single-ended triodes sure moved in fast and heavy for such an unlikely idea.

Unlikely, that is, from a technical electronics standpoint.Clearly, the notion had a lot of instant popular appeal as a sort of philosophical gesture. These days the finger automatically points at media hype, but I think the growth of SE had more to do with a willingness to believe in a new promise. It was a social movement of sorts.

Simple, low-power amps were a novel and radical idea, generating a context of mystification and surprise, and inspiring all sorts of revolutionary thoughts in the minds of audiophiles. Based on the cosmic implications projected onto the idea of SE, the amps were expected to live up to a higher set of aesthetic and spiritual ideals than the average unwashed tube amp off the street.

For a time, many believed that single-ended power amps had to sound good, before they even heard one. They had faith in what was basically a total unknown. Why is a very interesting question that has to do with a lot more than engineering principles, although certain pro-SE engineering arguments can be very instructively made.

Out there in the fertile minds of the audio mania public, the simple-as-dirt SE triode amp somehow got twisted up in a web of bizarre holistic single-ended intrigue, becoming a symbol for something bigger than bigness itself, occupying the sphere of creative lifestyle mapping and even taking on a deep spiritual new-agey dimension that most home appliances and tools do not inspire among their users.

Simplicity has always been holy to tweaks and single-ended no-feedback triode amps redefined the possibilities of minimalism.If simple is the goal, here was the golden path to the promised land. Get behind the wheel of a single 300B and you're there.

The sages say "Less is more" and perhaps it is—but it is still less, and if there is a SE-DHT Zen paradox at play, this is it.

One kind of power trades off against another kind of power. Low power amps have certain abilities that higher power units might not, but the argument goes both ways, back and forth, quite a few times.

Projecting from past lessons, I believe that it's a mistake to block any path just because it isn't the purest, coolest way to design according to this year's modes of techno-elitism. SE fanaticism sure is fun, but the ears know that there are plenty of valid ways to play music with electronic equipment. Open minds and clean ears are what paved the way for SE triodes. The further exploratory power of this open-to-whatever-works attitude is still tremendous. There's always more to discover.

Well, what next? Mini-watt amps may be great at special jobs like biamping,but thier low power ratings present obvious practical constraints, things being as they are with loudspeakers. The power shortage undeniably limits the systems we can build with this good-sounding technology. So, what about triode amps with more output power? Can we get some extra juice without paying too high a price? Although I am perhaps the world's biggest fan of low-powered SE triode amplifiers, one must admit that, in terms of output power, the only way from there is UP.

So, if either kicking some wide-range booty or expanding the practical applications of triode-fueled musical reproduction are among our goals, as they should be, let's see what else is up besides single-endeds.

A survey of old books shows that given known technology, available materials, and a few forgotten tricks, there are many ways to break the eight-watt barrier with some degree of class. And maybe some of them would not require selling our souls to the devil, although attitude shifts and mental readjustments may be required.

Back to the source

I wanted to build the 1948 Peerless A100 kit amp featured in SP #16 for about fifteen years, ever since I found that ancient issue of *Radio and Television News* at a flea market. Reading Melvin Sprinkle's article took me back to those innocent years before the coolness of SE, wu, the first watt, amorphous cores, and other fun wackyness of the last ten years of hyper-fi elaboration, back to the source.

What the ancestral Altec pro designers were after was a high-power TRIODE amp for home use, a very "purist" sort of thing back then, as it is today, now that we have relearned what triode amps can do about musical enjoyment in the home.

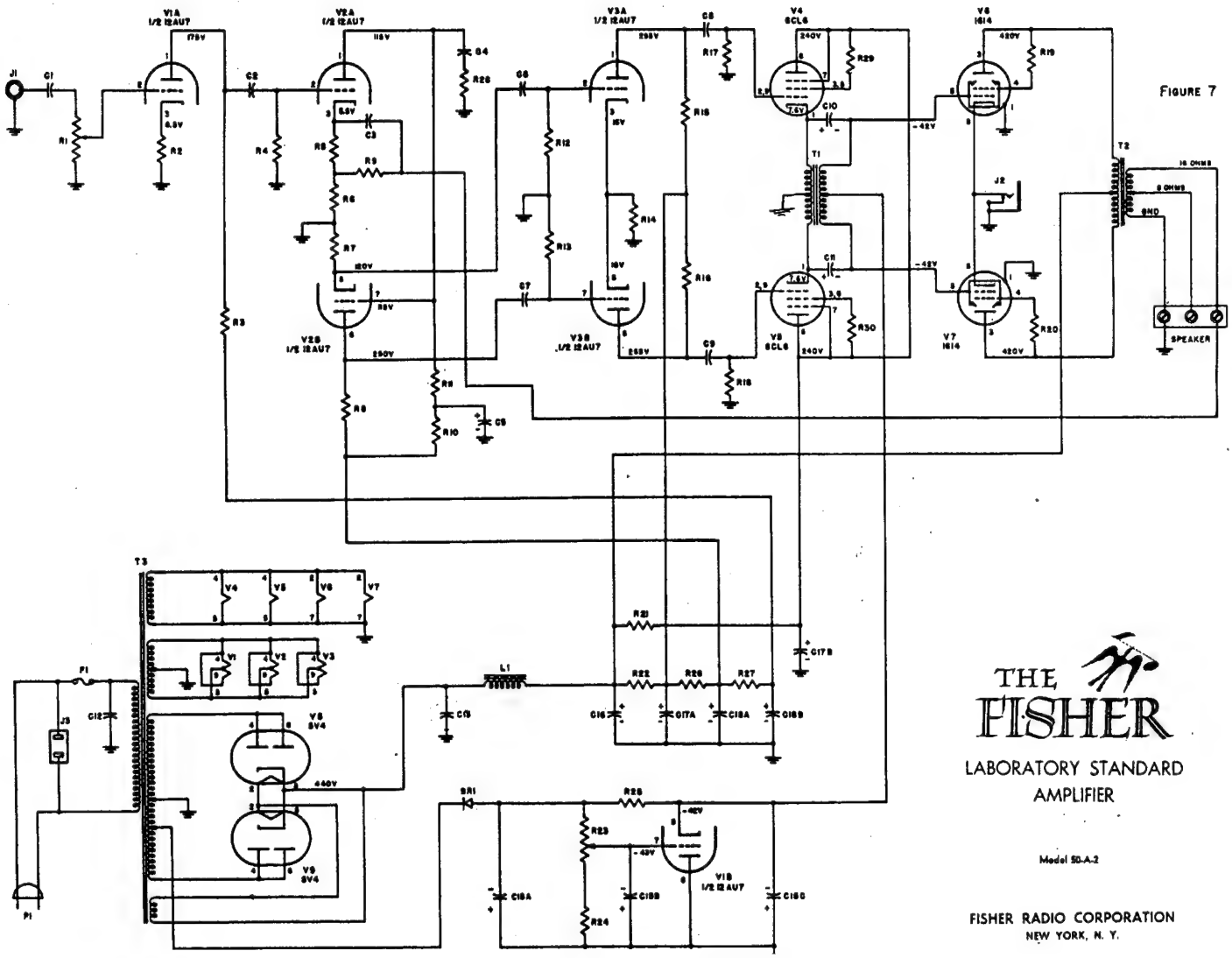
Okay, the power triodes in the A100 were an indirectly-heated variant, not our holy DHTs, the mode of operation Class AB2 not pure Class A, and the amp incorporates some now-dreaded global feedback, but this artifact of bygone industrial pro-audio design was obviously a high-aspiration package for the crack sound engineers who put it together.

Its link with our generation's practice is through the buzzword triode. When you wanted very high quality reproduction and were willing to pay a few extra dollars per watt, there was a lot to be said for triode amplifiers...and there still is.

In this design, Altec tried to address the power economy of the triode amp, beefing up the efficiency with Class AB operation. Contemporary triode hifi buffs insist on nothing less than luxurious Class A, the power limitations and the rapidly rising cost curve for output power above a few watts not withstanding.

Class A is expensive. An equal investment in tubes and parts delivers progressively much higher power in Class AB, AB2, or B operation—and so it was that triodes were typically used in olden days, even in exacting high fidelity applications such as cost-nearly no-object cutting head amps and such.

FIGURE 7

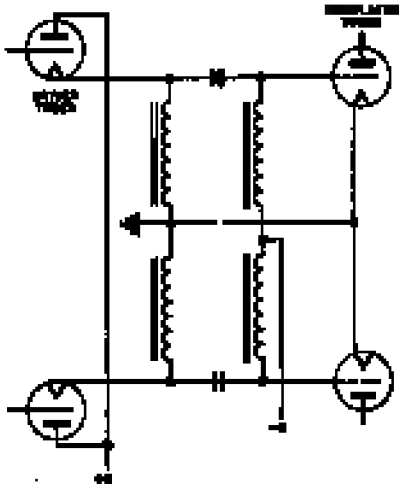


THE FISHER

LABORATORY STANDARD AMPLIFIER

Model 50-A-2

FISHER RADIO CORPORATION
NEW YORK, N. Y.

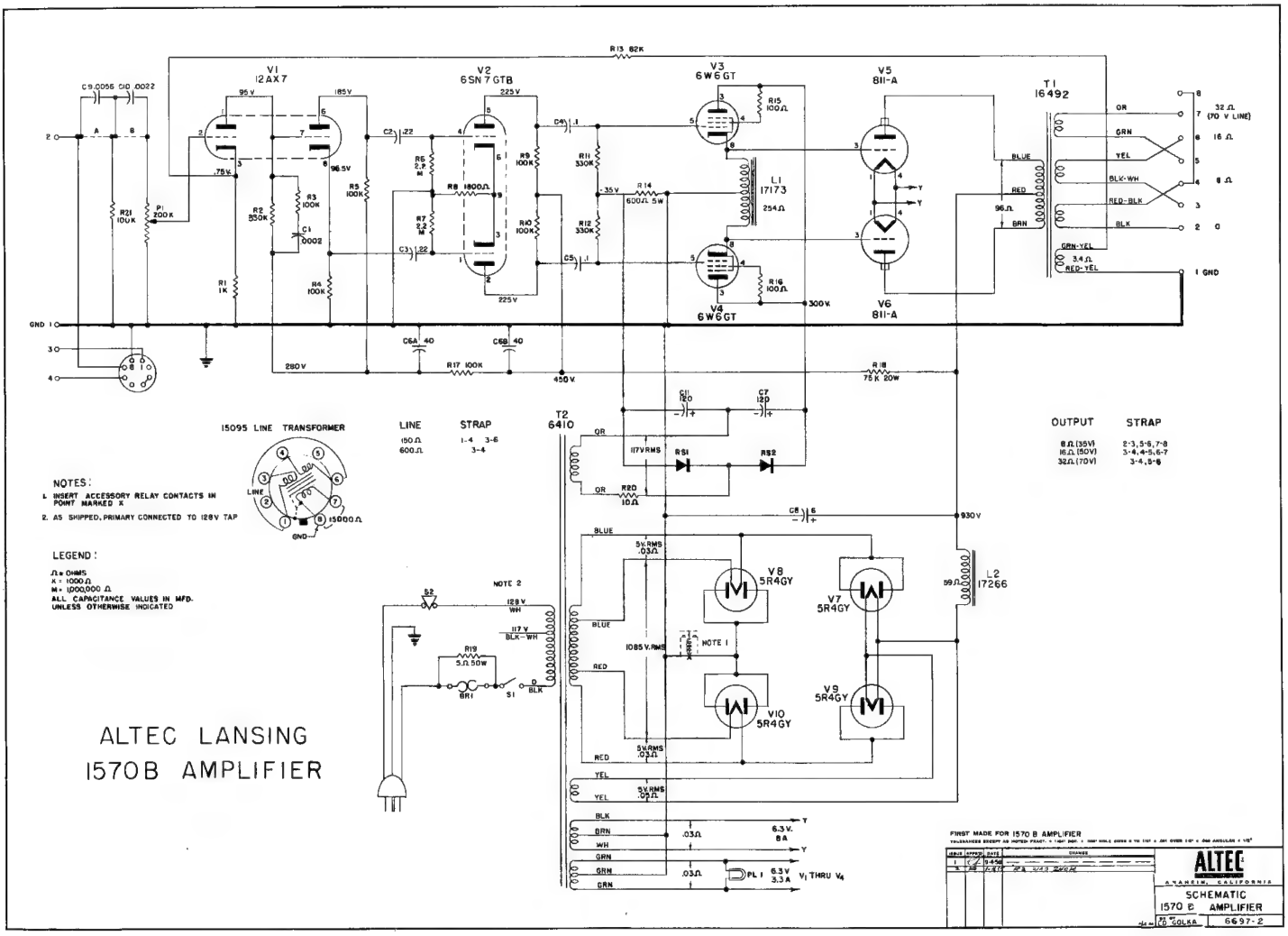


ABOVE: Though not the fashionable thing to lust after toda y, triode-wired PP pentodes with a lo w-impedance cathode follo wer driver sta ge were hot stuff in some upmarket early 1950s hi-fi amps, such as the Fisher 50A (6S4s or triode-wir ed 6C L6s driving triode-strapped 1614s) and later 55A which used this drive scheme for claimed effi - ciencies in excess of 55% with 50 watts out.

LEFT : Suggested driver topolo gy for 1940s state-of-the-art high po wer mod - ulator from Reuben Lee's 1947 text, "Electronic Transformers and C ircuits. "

Iron core components are emplo yed to provide required AC impedances with low DC resistance for minimum po wer loss,an important consideration in high power Class B amps which often pr e- sented substantial cathode cur rent and grid cur rent demands.

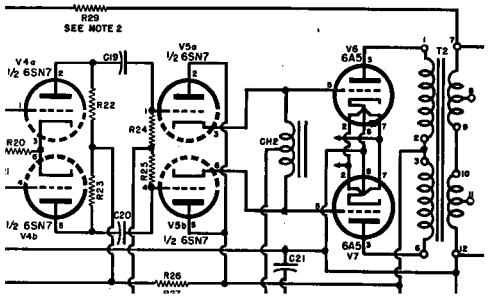
Symbol	Description
C1, C2	Capacitor, Molded Tubular: .1 mfd; 400 V
C3	Capacitor, Ceramic: 24 mmfd, 10%; 500 V
C4	Capacitor, Ceramic: 220 mmfd; 500 V
C5	Capacitor, Electrolytic: 1 mfd; 450 V
C6, C7	Capacitor, Molded Tubular: .01 mfd; 400 V
C8, C9	Capacitor, Molded Tubular: .1 mfd; 400 V
C10, C11	Capacitor, Electrolytic: 20 mfd; 150 V
C12	Capacitor, Molded Tubular: .01 mfd; 600 V
C13	Capacitor, Molded Tubular: .01 mfd; 1000 V
C15-A,B,C	Capacitor, Electrolytic: 20 mfd; 100 V; Com. P
C16	Capacitor, Electrolytic: 80 mfd; 500 V
C17-A,B	Capacitor, Electrolytic: 40 mfd; 450 V
C18-A,B	Capacitor, Electrolytic: 40 mfd; 450 V
R1	Potentiometer, Composition: 500,000 ohms
R2	Resistor, Composition: 4700 ohms, 10%; ½ W
R3	Resistor, Composition: 100,000 ohms, 10%; ½
R4	Resistor, Composition: 470,000 ohms, 10%; ½ W
R5	Resistor, Composition: 2200 ohms, 10%; ½ W
R6	Resistor, Composition: 1000 ohms, 10%; ½ W
R7, R8	Resistor, Composition: 47,000 ohms, 10%; ½ W
R9	Resistor, Composition: 2200 ohms, 10%; ½ W
R10	Resistor, Composition: 100,000 ohms, 10%; ½
R11	Resistor, Composition: 47,000 ohms, 10%; ½ W
R12, R13	Resistor, Composition: 470,000 ohms, 10%; ½
R14	Resistor, Composition: 4700 ohms, 10%; ½ W
R15, R16	Resistor, Composition: 100,000 ohms, 10%; ½ W
R17, R18	Resistor, Composition: 470,000 ohms, 10%; ½
R19, R20	Resistor, Composition: 68 ohms, 10%; ½ W
R21	Resistor, Wirewound: 4000 ohms; 15 W
R22	Resistor, Composition: 2700 ohms, 10%; ½ W
R23	Potentiometer, Wirewound: 10,000 ohms; 2 W
R24	Resistor, Composition: 2200 ohms, 10%; ½ W
R25, R26	Resistor, Composition: 4700 ohms, 10%; ½ W
R27, R28	Resistor, Composition: 10,000 ohms, 10%; ½ W
R29, R30	Resistor, Composition: 100 ohms, 10%; ½ W
F1	Fuse: 3AG; 3.2 Amp. Slo-Blo
J1	Jack: 1 Female Contact,
J2	Jack: Closed Circuit
J3	Jack: 2 Female Contacts

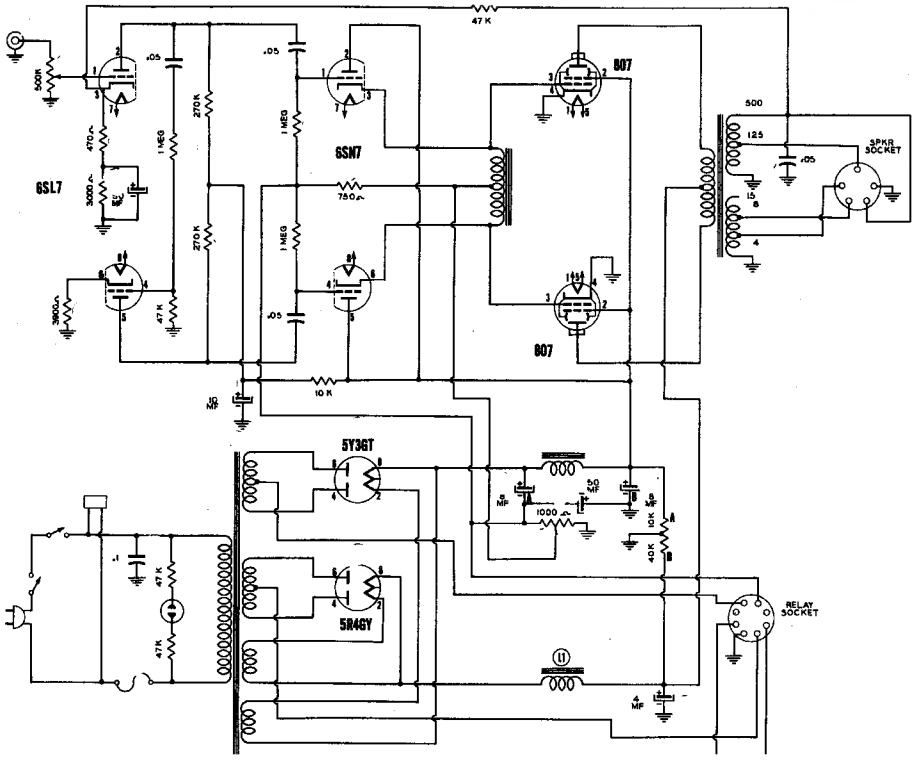


ABOVE: Famous Altec 1570B PP 811A amplifier put out 165W from 70 Hz to 20 kHz. People crazy enough to run these green monsters at home seem to like them a lot.

RIGHT : Bogen 807 PA Amplifier from early 1950s with similar driver scheme .

BELOW: Driver stage of Peerless A-100A 6A5G amp from SP#16 uses down - scaled version of 1570 driver arrang e- ment





There weren't many home hi-fi "triode" amps in the Golden Age of postwar hi-fi but those that appeared were Class AB2 high-power jobs—30 W for the Brook 10C and 50 W for the Fisher 50A. Thirty-plus watts was big power back then,some of the most potent amps available.

Things haven't changed all that much. Then as now, some high rollers wanted both high-power and triode quality. Unlike today, well-engineered Class AB or B PP triodes were then considered luxury-grade designs. Today's man wants A all the way.

All of the above-mentioned amps used interstage iron to cope with the DC requirements of AB2 service and you don't usually see this in vintage hi-fi amps. The transformers and chokes were there out of electronic necessity, not because of coolness factor. I doubt there was any "coolness factor" to interstage iron in 1948.

A comparison of circuits shows the Peerless A100 amp to be a "baby 1570" circuit, derived from the Altec 165 watt big mother 811A amps that powered drive-in movies and large-scale PA systems nationwide. In essence, the A-100s as triode hi-fi amps were a by-product of the reigning concepts of high-power triode commercial amp design, downscaled to domestic requirements.

My point about the historical respect for Class AB amps is not to argue that pure Class A1 (no grid current) operation isn't the best way to run tubes because obviously it is. A1 might be an energy inefficient, low power out way to do things but the constant current conditions of A1 greatly simplify challenges for the whole amp design.

Efficiency is gained by shutting one of the tubes off, fully or partially, for part of the duty cycle. When that starts happening, life gets tricky fast. Class AB and B amps are a dance of tubes switching on and off, grids driven into conduction, and related demands on the driver stage and output transformer, not to mention the need for a power supply that will keep up with all this energetic activity.

Short and simple, the more efficient the amp, the further away from the safe waters of simplicity we stray. Efficiency isn't free.

I understand that from a certain fashionable techno-purist perspective, the Peerless amp is a nightmare come true but I was thinking it might sound good anyway. That's why I finally built a pair after all that thinking about it.

Building my 1999 Peerless Amps

Since I was so enthusiastic about this experiment, I decided to go all out, using only the best components I could possibly scam, mooch, and gouge from my favorite suppliers and friends.

After a year or two of shameless begging, I had a pair of B-stock walnut chassis liberated from my pal Gordon at Wavelength, a nice set of repro Peerless iron from Magnequest in exchange for the race car pic in #16...



Then I had a box of exceptionally nice 2x10 mF 600V rectangular Micamold oil transmitting caps with inch-long ribbed glass terminals, pried from Ron Welborne's private stash, before I hammered him for a "friendly price" on the lot. I'm sure Uncle Sam paid some serious dough for these first time around. I didn't want to repeat that mistake.

Whew...collecting quality parts for a major project like this is hard work, but well worth the effort,I must say.

Speaking of parts, there are a lot of them in this amp and I had to work to fit everything onto a 14 x 12" plate. I had to use some steel sheet to isolate the input pot to kill hum, and some wires are longer than I would have liked.A 17 x 14"chassis would have been a real plus, especially with the big oil caps, but too late for that now!

For small parts, I chose classic American stuff that would have been the coolest in 1948. Allen Bradley carbon resistors and Type J volume pots, surplus ceramic power resistors, E.F. Johnson ceramic sockets, and Vitamin Q caps.

I couldn't resist using a Western Electric 4 mF oil cap for the 6J7 screen bypass because I found a couple of these industrial beauties in original Signal Corps packaging years ago and I've been waiting for a circuit where I needed 4 mF to come across my bench! The gold and black water-slide decal makes these the baddest vintage parts in the junkbox.

On the other hand, I did install some extra decoupling with fresh datecode Cerafine caps and I used a couple late-model Black Gates where funky 1940s electrolytics were specified in the original plans.

Then, I switched out the Vitamin Qs upon arrival of the "care package" I weaseled out of Charlie Kittleson at VTV Pro Shop, importer of Ultratone silver and paper oil caps. I wouldn't have kept them in the amp if they didn't work better than the Qs, but I couldn't argue with the combination of softness and sparkle the silver caps added. I'm not much of a silver freak,but I did like the smooth but well-defined flavor of the Ultratones enough to try to mooch a couple more when I need livelier and more airy coupling caps than classic surplus paper-in-oils. Be sure to mention "Joe Roberts Labs" when you place your order to pave the road for future "review sample" raids on VTV Pro Shop.

In the end, although I intended to stay as original to the classic design mentality as possible, the parts selection process led to many modern audiophile substitutions and even the old parts I used were generally higher-grade than what Altec used. Why limit myself?

The end result is that my 1999 Peerless amps look like what they are—fancy home-made hyper-fi triode amps of 1999, an eclectic melange of selected fancy parts, from new to 60 years old, arrayed on a hardwood presentation-style chassis that those rack-mount minded ALTEC sound engineers would never specify for an hard-working audio frequency amplifier.

How Do They Compare?

I suppose the big question is not how cool my homebrew project is as an objet d'art, but rather how do these feedback push-pulls compare to a SE no-feedback triode amp I could build with the same level of attention and the same basic parts quality, for about the same investment?

I would have to say that the comparison is very instructive and says a lot about the relative ups and downs of SE amps. One thing that is gone with the PP Peerless amps is that over-the-top emotional expressiveness that is the recognized specialty of no feedback SEs. The Peerless amps are more controlled and restrained, which is both a plus and a minus, depending on when you ask and how I'm feeling.

Unlike the pleasantly puffy low end of my SEs, the bass of the Peerless amps comes across well-damped and tight. Some of the apparent weight behind the low end delivery of SEs is lacking, replaced by improved transient edge definition, but I've been wondering whether a lot of SE bass, while quite pleasant, isn't overblown and melodramatic anyway.

I'd have to mirror similar assessments across the audible frequency range:This PP triode feedback amp seems to be freer of sonic special effects than a lot of the single-endeds I have known and loved.

I suppose one could say that these PP amps sound more realistic and natural in many ways because they don't engage in audience manipulation like SEs. However, the juicy excesses of SE are part of what I liked about the breed.What's wrong with a little excess when you're in the mood for it?

The pronounced character of some SE amps seems to work in favor of music listening *sometimes*, but this depends on the system, program material, and listeners, on a case-by-case basis. The Peerless was more tonally austere than the average 300B SE, but the color and vividness was still there. The leaner sound of the A100 added some emotional contrast which can get drowned with a really lush. beautiful sounding SE.

Probably, SE triodes are still the undefeated champs of midrange, but in most situations low-power NFB SE bass is definitely beatable, even though often not bad. One answer to this age-old dilemma, of course, is multi-amping, perhaps still the ultimate way to go if you've got the space, the amps, and the inclination to mess with it.

Is this push-pull amp a world beater? No, I wouldn't go that far. In fact I think I could build a single 300B amp for the same money that could well turn out better, if "better" means more dramatic, more impressive and attention getting. The Peerless amps aren't much of an audio circus act compared with a lot of the stuff out there.

I do miss the psychedelic SET midrange a bit, be lying if I said otherwise, but I like the tasteful natural presentation of the upper mids and highs from this amp as well as the snap factor and rhythmic aptitude. Not dry, not over the top, not soft, not hard-edged, the Peerless amp project gave me a well-balanced upbeat result that is quite a satisfying listen. It has balance.

Maybe I'm just burned-out on reviewing, but I can't think of very much to say about the sound of this amp even though I like it a lot—and that is a compliment, I think.

THE ATMA-SPHERE M-60,Mk.II

As discussed above, the noble goal of whuppin' butt with triodes is best approached with an open mind regarding topologies, techniques, and tubes. Lo-watt SE-DHT has a lot going for it, no doubt, but the would-be butt-whupper might want to cast out a wider net.

One amp topology that hasn't lately enjoyed the cachet it used to have is the Output Transformer-Less (OTL) scheme. Maybe with good cause, because the OTLs that were major excitement back in the old days just never really delivered the goods, if the goods you were looking for are the absolute very best in sound.

Perhaps one reason that OTLs got stuck at very good and never hit the jaw-dropping great level is that the traditional OTL scheme *a la* Futterman required a huge capacitor at the output to block the B+ from running through your speaker cables and voice coils.

Though traditional OTLs with massively parallel sweep tubes and 3000 mF output caps had nice body in the lows and mids, the highs usually sounded kind of snuffed out and/or grainy. I blame the cap, although the very high levels of negative feedback used in Futtermans probably didn't help with the mechanical sound tendency.

Many old-time tube devotees thought getting rid of the "nasty" output transformer was worth putting a several thousand mike electrolytic cap directly in the speaker line, but I personally never had a problem with output transformers, except that good ones are not free.

Over time, audio hipster ideology shifted to the belief that transformers sound good and folks want more and more iron, anywhere, everywhere. Today, a poll of maniac audiophiles would probably show that iron is well-loved and it is capacitors which are believed to be the scariest devices in audio. In these pro-transformer days, OTLs have lost much of their former cognitive appeal.

Still,if one could get rid of the cap and the output iron, that might be something to hear. And that is what Atma-sphere has been doing for almost 20 years with their adaptation of the 1950s Wiggins Circlotron bridge circuit to OTL amplifier design.

Atma-sphere keeps the DC out of the speaker coils by using equal-but-independent floating power supplies on the two sides of the bridge in such a way as to have the output terminals between them at zero VDC potential.

Ralph Karsten, chief designer at Atma-sphere, is a tube nut of the first water, been around for a long time and he's seen it all. He's very thoughtful and well-studied on the general subject of tube audio, and although he's been in the biz for decades, he's still really excited about tubes and very refreshing to chat with because he obviously still loves what he does. Beyond that,he's an outre ethno-musician, former sitar and sarod picker, now specializing in Native American flute! As just another white boy blues harp player, I'm impressed!

Well, more than twenty years ago, Ralph latched on to the kernel of the old Circlotron scheme and took it places it had never been before. The original EV Circlotron amps were Class B pentode jobs with output transformers, bearing little concrete resemblance to the refined and patented Atma-sphere OTL topology.

On a structural level, "circlotron" is just a geometry, a configuration, like SE and PP, and it can be adapted to many uses. The M-60 design is an output capacitor-less OTL that is a pure Class A, low or no negative feedback (factory option), genuine triode design, using inexpensive 6AS7 output tubes, delivering a whopping 60 Watts output into 8Ω. Looking at it that way, sounds

pretty interesting, and a whole lot more interesting than the vintage Circlotrons, which were mainly techno-curiosities.

The only buzzword purism sins these amps commit is that a) The M-60 is not a single-ended design and b) It uses indirectly heated tubes instead of the canonical DHTs. So what, this well-conceived scheme is, in all fairness, exotic enough to hold its own in any parade of lunatic fringe designs. If a triode OTL isn't arcane enough,get a life, you know?

Actually, the manufacturer worked hard to make the M-60s a practical non-exotic product, as simple and trouble free as possible, based on common tubes that would be widely available in the future. The lifespan of a tube amp is fairly long and Ralph likes to think in terms of a "twenty year rule" which implies that he wants and expects to be able to support 1999's Atma-sphere amps in 2020.

The M-60s classic silver hammertone, deco-mil-spec retro styling make for killer industrial art up on the shelf. Form-function electronics surplus *objets trouvees* like jeweled red and amber pilot lights with real incandescent bulbs, bat-handle toggle switches, and a photo-etched mil-style nomenclature tag evoke the saga of tube electronics through the ages.

This classic form-fits-function visual design is a virtual celebration of the romance of bygone technology. With the pilot lights glowing and the 6AS7s all lit up, they put the Christmas tree to shame.

Yet, like anything that is cool about being self-reflexively retro, the M-60s don't overdo the act.Indeed,when they're on there is so much luminescence from the tubes that it is hard to focus on the metalwork! With tubes galore like this, you don't need ornamentation to augment the visual appeal.

One brute fact that struck me was the moderate weight of the M-60s. Although each chassis has a substantial 17 x 13"footprint, my last stupid-heavy, oil capped, choke input power supply, output transformered DIY linestage weighed more than one of these under-30 pound OTL monos!

As mentioned above, it is also easy to notice that there are a LOT of tubes in these monoblocks, definitely a tube-lovers' tube amp! The output stage consists of eight 6AS7s per side, an industrial dual triode that has the sexy coke bottle curves that gentlemen prefer. The manufacturer uses and recommends Russian 6AS7s and warns against NOS RCAs because they tend to flash over at turn-on. NOS Sylvanias, apparently the prototype for the Russian versions, will work just fine.

Fortunately, 6AS7s are a durable industrial type, plus a common and reasonably priced current production tube, so retube considerations shouldn't be too painful. Atma-Sphere gets about $20 each for cherry picked Russians and you can probably pick some yourself for even less.

The voltage amp and driver stages use four 6SN7s per side. The voltage stage uses a differential cascade arrangement employing two bottles, with paralleled halves of a 6SN7 working as a current source for the differential pair. The output of this unconventional voltage amp hookup is coupled to the grids of the 6AS7 array via a pair of 6SN7 cathode-follower drivers.

The input of the M60 is capable of being driven by a differential input via the front panel XLR jack, or via unbalanced RCA inputs with a little shorting jumper stuck into the XLR, as seen in the photo. Atma-sphere's preamps employ balanced differential outputs to maximize this capability and present the opportunity to have a balanced differential system all the way through.

I suppose the ultimate irony of the Nineties would be to take one of those high-fashion line stages with a balanced transformer output and drive the OTL with some output iron. Why not? It's still legal to get crazy like this, for now.

Like all OTLs and tube amplifiers generally, but OTLs especially, the M-60s like a highish impedance load, 8 ohms or better. The M-60 is rated at 60 watts into 8 ohms but 45 at 4 ohms.With 4 ohm speakers, the damping is somewhat compromised and the bass can sound a bit undercontrolled, according to Ralph. Atma-sphere's bigger OTLs, using more output tubes for lower output impedance, are happier with 4 ohm loads.

The M-60 is usually shipped with a moderate 2 dB of negative feedback to assist in driving low Z loads, but they will send you amps with no feedback upon request. The dividing line where feedback starts to help is the 8 ohm point.Above 8 ohms, it doesn't matter much if the amp has the feedback or not.

Ralph claims that they tried a feedback switch but the difference between no feedback and 2 dB feedback was quite subtle. On the other hand, the effect of switching between 8 dB and no feedback,which they also tried, was quite dramatic and suggested that the lesser amount of feedback was far the better option.

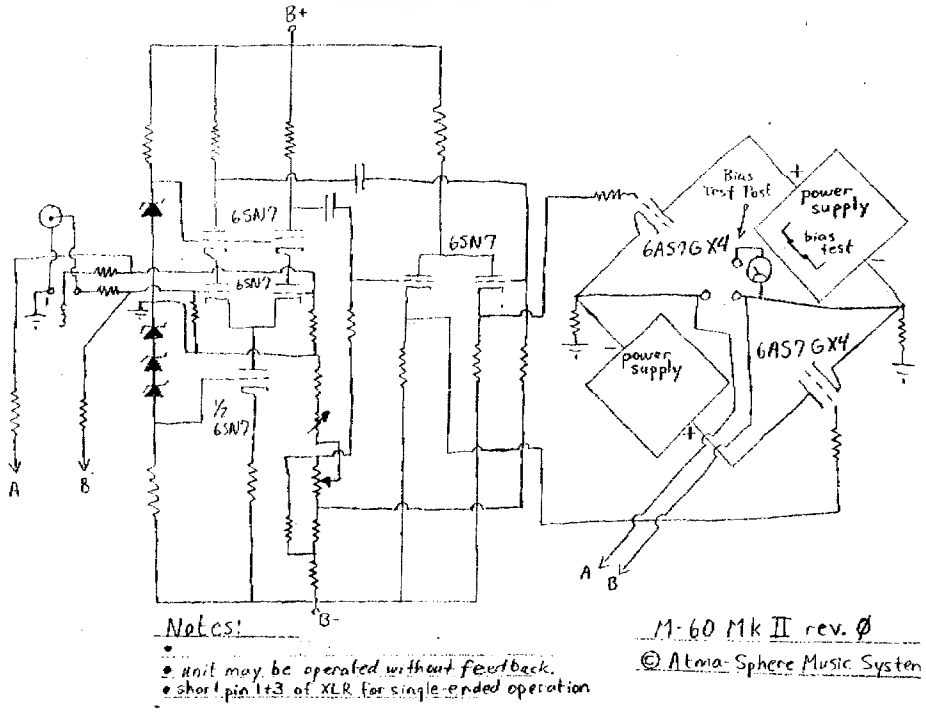
One of the reasons the M-60 aroused my interest is that it is available in kit form.My ears always perk up at the mention of a kit. Aside from the abstract pleasures that kit building provides, its hard to ignore the positive economics of going the kit route.



The storebought version goes for $4195 and basic kit goes for only $2495! That's getting close to the point where you can get a biamp quad set of M-60 mono kits for the price of one pair of ready-mades, a discount not to be sneezed at.

Although the M-60 chassis is quite spacious and the components are not crammed into the box,this amp has a lot of connections in it, a lot of wiring snaking about. By the looks of it, I would have to rate this a kit project of at least moderate

Atma-Sphere M-60 Mk.II OTL Amplifier
Schematic Diagram



difficulty and scope. Like the Peerless A100 discussed above, the M-60s have a lot more parts in them than most simple SEs, so this would be a somewhat bigger undertaking than a 91 amp or similar DIY SE special.

Since it's a kit, though, you're saved from the exacting dog work of the metal shop and you can rest assured that the end product will look better than what 99% of garage homebrewers could accomplish. And what you'll end up with is a name-brand item, in case you ever want to move it along. There's not much buyer demand for ugly scratch-built homebrew OTLs these days, so you can build it for less yourself from scraps and throw all your investment away.

Compared with what you can buy ready made in 60 watt monoblock triode OTL amps for $2495, I'd have to say that the Atma-sphere kits easily hold their own, if you know what I mean. Seems like a good value package for the money, even without hearing it. And I am pleased to give these amps an enthusiastic thumbs-up for the way they sounded too.

Although I have only heard four or five OTLs, these are easily the best OTLs I have heard, but beyond that I'd have to say that they are wonderful TRIODE amps, enjoyment+ for music listening. I found myself digging out old R&B vocal harmony sides and roots reggae records to play on the M-60s. Great, great T-Bone Walker amps and outstanding for bluesy female vocals like Etta James and Dinah Washington, the M-60s have a lot of character and create a lot of atmosphere in the listening room…or is that Atma-Sphere?

There's no mistaking the special tube flavor of the sound of the Atma-Spheres, a nostalgic, grandiose tone that evoked a classic vintage tube amp sort of charm, but I would be hard pressed to name any specific vintage amps that sounded like these do. Most vintage amps don't compete with the M60s in terms of immediacy and fresh air. These amps are colorful without sounding deadened or muffled like most antique units.

Even though the M-60s were a new experience for me, they sounded very familiar, very friendly. Smooth beyond smooth, the M-60 is easily the most fluid, grain-free amp I ever heard in my life. Very easy listening. Maybe THIS is why people want OTL/OCL amplifiers?

The mental image I'm trying to find words to describe is the big triode jukebox sound—vivid, dramatic, super bouncy bass, big liquid midrange, 3-D effects out the yin yang. The M-60s are a very fun-filled, hedonistic listening experience that has a lot of the tonal romance of a 300B single with much more grunt and power.

I say romance because like a triode SE, the M-60s present a blatantly "tube enhanced" portrayal, but like the good SEs, the M-60s do it in a refined and sophisticated manner that adds to the comfort and enjoyment level of music listening without coming across as a cheap overdone special effect.

Right before packing them up, after a couple hundred hours use, one Sovtek 6AS7 heater went out. Didn't even notice at first because the amp kept playing fine. Could have been like that for a week or two before I noticed it. No explosions, no fires, no meltdown. To be honest,I couldn't even hear a difference. OK, I'll turn in my reviewer's license at the door.

Otherwise, the amps ran problem free for the nine months I had them. Some tweaking and adjustment is required at setup and during the initial burn in period.After that, they didn't require any attention. I was worried that they would be flaky about adjustment but they were very stable. When I swapped them in and out of my system, I periodically checked the bias and balance, they were more or less still right on.

Worthy of note is that sixteen Class A 6AS7s definitely throw off some British Thermal Units as a by-product of that fifty watt Class A output. Ha, Ha—Did you think Class A was free? I noticed the extra warmth in the listening room after the amps cooked for a while but I live in sun-baked Texas and I'm used to running low watt two tubers.

I will mention that my fellow Texan, John Day (who lives in a part of Austin just as hot as here) heard these M-60s and blurted out the analysis that "they sound like a powerful, well-broken-in engine!" He begged me to borrow them to run his Altec A7s and he was on the verge of buying, until his wife threatened to move in with her mother if he bought another tube amp. John says they're the best amps he ever heard on his horn system. I say about time you heard a real amp, bubba!

Another Austin audio buddy, jazzbo triode DIYer, Dexter Guilford, came over to hear the Peerless amps a few weeks ago and he promptly called LaFevre and bought a set of Peerless kit iron. Different strokes for different blokes.

The moral of the story—aside from the obvious implication that I should be out

shaking down manufacturers for even more payola—is that there is still a gold mine of good ideas off the beaten-track and a lot of potential payback in prospecting out in the unmapped fields of audio experimentalism. The chances are that you and I would find much to enjoy among the possibilities.

The real subject of this article is something that is impossible to put into words: how these amps sounded similar, while sounding quite different. I'm trying to probe how they are both examples of triode amps, without invoking the almost-useless, non-descriptive buzzword "The Triode Sound," even though that's what I'm wanting to say.

Both amps have the quiet background and the natural yet colorful tonal palette I expect from triode amps. Both designs were relaxed and smooth without being muddy and obscure, and that's a quality I can definitely relate to triodes.

Both amps were forgiving of the quality of the source material, being friendly to less-than perfect records and recordings. As Herb Reichert once put it, "A good amp is one that plays all of your record collection." Triodes, to me, mean easy listening.

The M-60s were a bit softer than the Peerless amps, the bass was a bit more full and punchy, and they were perhaps somewhat smoother than the PP homebrew monos, all the while sounding three times as powerful, which they are.

The A100s had a bit more of a high-definition information retrieval illusion and the whole presentation was slightly shifted toward brightness a notch from the bouncy, rich midrange of the M-60s. The A100s had more gritty bite in the upper mids than the Atma-spheres, which was nice on cymbals, but,from another perspective, the utter lack of any nasty edges was a positive feature of the OTLs.

Despite certain pronounced differences in flavor between these amps, there's a remarkable alikeness in fundamental presentation characteristics—the way they projected music into room space, how they rendered texture into the body of the sounds, how they engaged the ear— which is not to say that either amp sounded generic.

The two sets of amps represented two wildly divergent concepts of amp design, yet they sounded like they were swinging from the same family tree, the top branch on the Triode Bush, perhaps.

I mentioned the triode similarity aspect to Ralph Karsten and he suggested that maybe this is an example of a wider phenomenon where the sound of amps tends to converge as said amps get "better." He said, "Music only sounds one way—like itself—and this is why as amps and speakers get better they should exhibit less difference. So it should come as no surprise that two high quality triode amps of different design should sound similar if all the ducks are in a row."

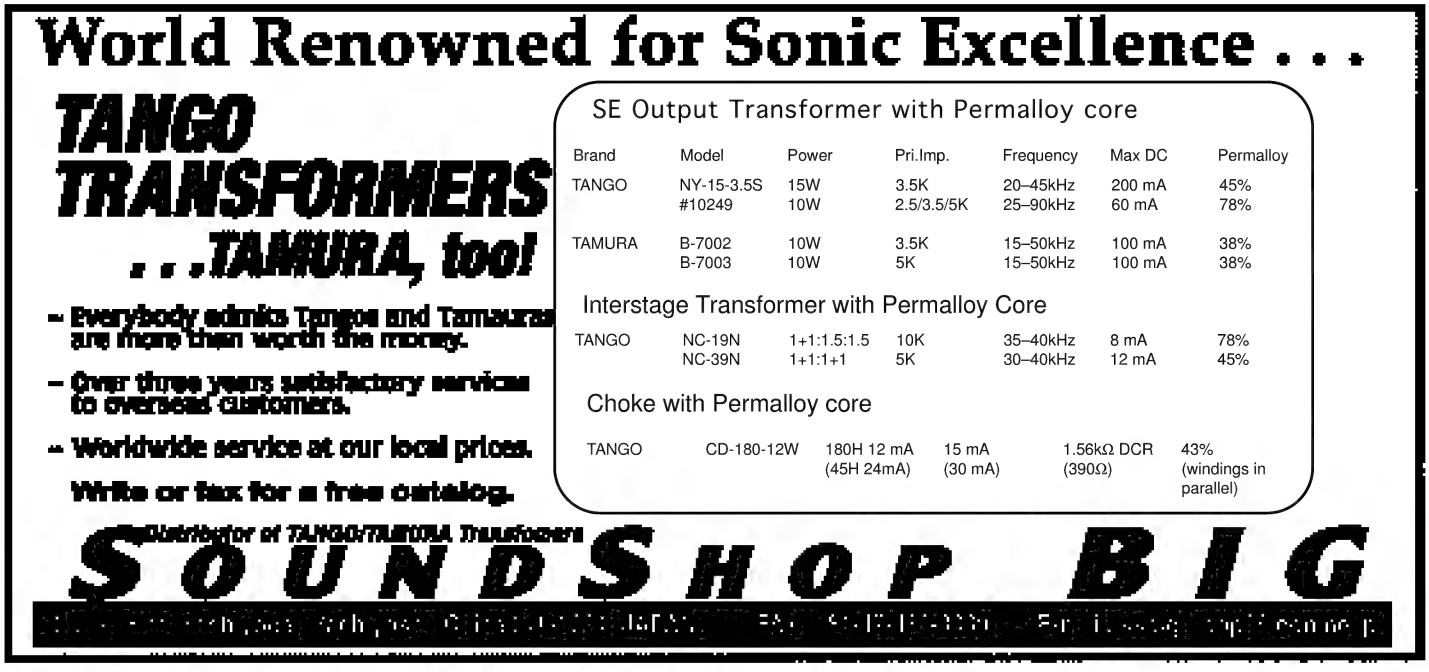
There could be something to that line of thinking, although I'd want to leave the question of "better" as open as possible to allow for future surprises.

I will say this, that as I listen to more triode amps—single-endeds, push-pulls, low power or high power, directly heated or indirectly heated—I'm hearing a lot of the same things. Good things.

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http://www.condor-connection.org/aso g



Manufacturer's Comments— Ralph Karsten of Atma-Spher e

Our goal with our amplifiers was to create a new type of amplifier that had never been made;not just for the fun of it (although we had a lot of fun anyway) but because it might serve the music.The result was the world's first reliable OTL (a term that sometimes makes us cringe because of the unhealthy legacy left behind by Futterman and his heirs).

We made the amp reliable by also creating the world's first symmetrical OTL, negating the need for the dreaded negative feedback that kills music. We believe in the principle of Occam's Razor: the simple solution is probably the right solution—so the amp has only one stage of gain, making it, so far as the music is concerned,the simplest tube amp in the world.

It is the only amp in the world that is Class A, all triode, fully balanced (differential) throughout, zero(or 2db) feedback with a single stage of gain and a direct-coupled output.A bit of a mouthful,but the better your speaker the easier it is to hear how much better it is.By comparison, it is a little less colorful than most SE designs, due to its lower distortion. You'll get used to that real fast. Once you get used to hearing this, SE amps tend to sound harsh by comparison.

We don't like feedback at all but were forced to deal with the issue in the M-60.The problem is that altogether too many people want to use tube amps with the wrong type of speakers.So if you haven't heard it before, you are hearing it here now: IF YOU LIKE TUBE AMPS, STAY AWAY FROM FOUR OHM SPEAKERS!!

The fact of the matter is,ALL tube amplifiers perform better on 8Ω or 16Ω than they ever could on 4Ω.Of course, having said that,there are a lot of 4 ohm speakers that work fine with our amps,but all other things being equal they would all work better if they were 8 ohms instead.

OTLs have gotten a bad rap not only on account of reliability but also load sensitivity. The thing about that that surprises a lot of people is the revelation that transistor amplifiers are actually MORE load sensitive (although in the opposite direction,less power into high impedance, the opposite of tubes).

We have built the only DHT OTLs in the world. We used the 300B (4 per channel) and produced 14 watts into 8 ohms. The amp sounds very similar to our 6AS7 based designs, in fact, the choice of output tube has only a small bearing on the sound we achieve.

I've often thought about using the 2A3,since it would be a cinch, but once you've gotten used to really clean power its hard to get by with less—I like to rock! 2A3s would require quite a few on hand to do anything significant.

We have finally introduced the S-30, a 30 watt stereo amplifier, in our quest to offer OTLs at an affordable price. Actually, our vision has always been to build the 'OTL for the masses', something that was only a dream before we made reliable OTLs a reality.

Despite the fact that we make only balanced amps and preamps, we have always felt that we had more in common with the single-ended crowd then the powerhouse (read: club-handed) push-pull camp. That is because we have shared the vision of simplistic circuitry with Class A triodes and zero feedback. For what its worth, we have been making triode amplifiers for a longer period (over 21 years) than any other manufacturer in the world.

The SE revolution served to legitimize our way of life;in the 70s we were simply thought of as nuts ("triodes? really? I gotta go.."),in the 80s, quaint,if not a little exotic , and in the latter half of the 90s (after 20 years) we are finally experiencing market acceptance. The presence of high efficiency speakers has been a boon. We have many Lowther and horn customers (and have had a long relationship with horns on the home front as well).

One nice thing about this OTL technology is that the sound is not limited by high power. Our larger amps actually sound better than our smaller amps,flying in the face of conventional wisdom.

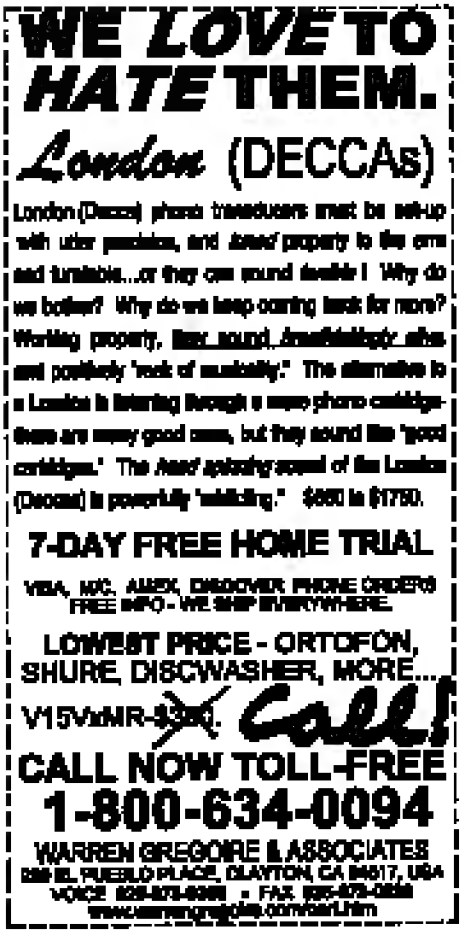
This means that lower efficiency speakers can be used, but even with a set of the 220 watt MA-2 MkIIs,its nice to have a speaker that has efficiency in the low nineties rather then the mid eighties! If you ever want to hear how good the recording really is in Black Sabbath's "Paranoid," you simply have to have a speaker that's easy to drive!

By the way, our amps are so reliable that they hold up easily as guitar amplifiers. The only problem is that they don't 'bite' like conventional guitar amps do because they won't distort as much.

A last word. The thing that has always made Sound Practices a cool mag has been the simple fact we must emphasize having fun in the process. FUN is the most important aspect of audio. Avoid der tube Gestapo! I hope you get where we're coming from.

Thanks and happy listening!

Ralph Karsten

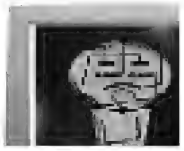


DARLING FEST '99





Our DIY cybergang meets in the flesh



by Jeremy Epstein

The "Be-There-or-Be-Square" audio event of the week, for sure!

One of the facts of modern life is that you can make friends now before you ever meet them. One such friend I've made is rocket boy Bob Danielak,who, when he is not engineering power systems for com satellites, designs and builds (oh, how he builds!) a wide variety of audio equipment. I had made his acquaintance via e-mail when I took a design of his, an RIAA preamp, and hacked it all to hell. We hit it off and kept up a running discussion of long standing.

One of the topics we touched on was Bob's "Darling" amp, during the early stages of its evolution (see SP #15.) He was touting his little SET amp design,using the 8532 seven-pin-mini single triode as its driver, and the 1626 pre-WWII power triode as its final tube, as a great bang-for-the-buck project. I was dubious at the prospect of building a <1 watt circuit as my first triode amp, but the words "cheap" and "fun" kept resounding loudly from his description. I decided to try and build a push-pull version of his design, an intimidating 1.5-watt behemoth, and Bob helped me cut and paste a circuit together using an IT phase splitter.

I built one. It sucked.

I quickly rebuilt it into an IT coupled, single-ended amp using the two 1626 power triodes per channel in parallel, since they were all wired in there anyway. It used a 6SN7 dual triode as driver for both channels, because I like the sound of this tube. In my dusty pile I found a 6BY5 dual damper diode pulled from the back of a discarded TV, so I had tube rectification and everything.

It kinda sucked too, but it was a step forward. I'll spare you some of the gorier experiments along the way, but finally I decided to try ditching the IT altogether and cap-coupled the driver straight into the parallel 1626's.

This one didn't suck. In fact, I played it for about 200 people at Blackie Pagano and jc morrison's thermionic love-in, nyNoise, and the crowd was very happy with it.Suddenly I was a "made" member of the NY Triode Mafia. The highlight of the day, however, was meeting my faithful consigliere, Bob, face to face. (Face to face to face, actually: he brought his identical twin brother, Rich.) Since then, with Bob's wise counsel, I've developed an even better, DC-coupled version of this amp. All these amps have, true to Bob's word, delivered shockingly good value. I promise you, if you build one, you will be ruined for expensive tweaks forever, so the project will pay for itself, eventually.

One eye-opener I discovered in my DC-amp explorations was that the conventional power supply arrangement for a two-stage amp, with a pi filter between the B+ tap for the final tube and the B+ tap for the driver, does not sound as good as a single B+ tap arrangement.

Moving the driver tube's supply to the final tube's B+ tap was one of the biggest improvements I heard during the development process. The soundstage increased from the size of an East Village apartment bathroom to the size of a hotel ballroom with just this one switch. Doing this also allows you to increase the value of the driver plate load resistor (you drop voltage there instead of in the pi filter) which gives better driver linearity, all else remaining equal.

Bob has confirmed this improvement in his amps. We have speculated about it and our belief is that the reorganization of the lead/lag of the power supply time constants sounds better. The single tap approach creates a 180-degree difference in phase between the two stages' PS demands at all frequencies, instead of a frequency-dependent lead/lag. This was the biggest design contribution I was able to make—my approach is more that of a mechanic than a designer, Bob did most of the heavy mental lifting. The only caveat is that the B+ tap you use must be filtered well enough to begin with for use in the driver stage: the conventional arrangement is usually for the purpose of improving the filtering of the B+ for the higher-gain driver stage. Doing this



may be good engineering but we found it exacts a sonic price. Ps decoupling between stages is unnecessary in a two-stage circuit.

Another thing I discovered, at nyNoise, was how much fun it was getting out of my basement and meeting some of the people who I had known only as e-mail addresses. I met Larry Moore and "AnnaLogg" there, and the "Darling Fest" project got its start that day.

All the while, back in his garage strewn with tubes and Fiat guts, Bob was performing all manner of vivisections on hapless donor chassis. He was working more with single-1626 final stages, because he hears a more precise and delicate image from these than he does from a 2 x 1626 final stage. (He may be right,too, but I gotta be able to play "Live At Leeds" from time to time, y'know?)

After he published his article, and while we continued posting progress reports to the JoeNet e-mail list about our further experiments, we attracted some fellow travelers. There are at least a couple more people who have built Darling-style amps (there may even be dozens, I get frequent e-mail queries and Bob gets many more.) I have also seen another different circuit on the WWWeb, developed by a Japanese enthusiast, which uses a 1626 final stage. Apparently, the word "cheap" can be translated into Japanese.

Bob doesn't have an electronics problem,he says, "I can quit any time I want." Nevertheless we were able to take seven different amps of his, and add to them my three, plus one made by that fellow Larry Moore who is quite the amp craftsman. Larry built his with a volume knob, and he goes forth like Johnny Ampseed, patching this nifty little SET amp into the signal chains of everyone he meets.

In numbers, at least, we thought we were getting somewhere. En masse we wormed our way onto the schedule of the New Jersey Audio Society, at the invitation of Valerie Kurlychek, a.k.a. "AnnaLogg."

Bob, his twin brother Rich, and I negotiated the spaghetti-like roads of Brick, NJ and arrived at "Anna's" door early one Sunday afternoon. She gave us a quick demo of the house system, which delivered more output power in one channel than all ten of our amps combined. Nice power, too.

Some folks started straggling in soon thereafter, and we put in a pretty full day: the "Darling Fest" started about 2 p.m. and we were still playing "let's try . . . " and "what if we . . . " after 8:30. We promised her an entertaining day, and I believe we delivered. The listening panel was uniformly well pleased,and we got comments like "This has been a real eye-opener," and an incredulous, "We're still under 1 watt output here?"

For me, a dozen amp setups are too many to listen to in one day. We played anywhere between two and eight tracks on any one amp, and we played a single benchmark cut on each (a version of "Take Five" by a group led by original Brubeck drummer Joe Morello.) We sure heard far more drums! My preference in auditioning equipment is for month-long trials, (Ongaku donors, take note) covering all sorts of music, and I did try to provide some variety in the cuts I selected for our quick comparisons : Eddie Cochran, Kurt Rodarmer, D.L. Menard,Ray Charles.

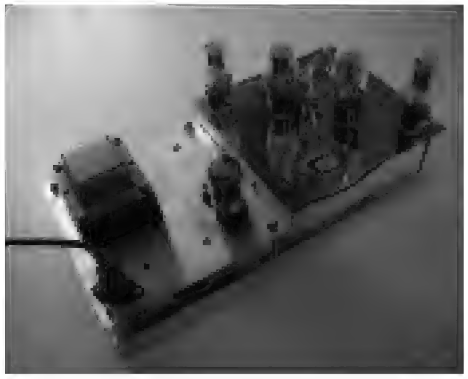
The "house" software contrasted nicely with my selections:"Anna" came up with the Joe Morello and a sweet-sounding disc of recordings made using a Stradivarius violin which were particular hits. The Strad disc made very good use of the Darling family's strong points, and a lot of eyes rolled back in a lot of heads while it was playing.

Ancillary equipment included an excellent pair of Von Schweikert VR4 Generation II speakers, and some very spiffy front end equipment :Musical Design Signature 2 CD player, Balanced Audio Technology VK-5i line amp and Margules Audio phono pre. Phono cables were WireWorld Gold Eclipse II, and the preamp was connected to the phono stage with Harmonic Technologies





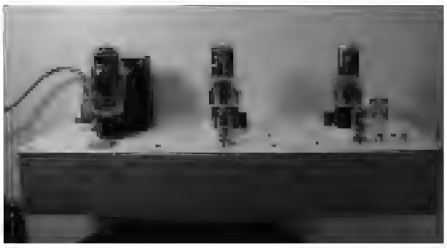




Truth-Link. Speaker cables were Vampire as were the CD-player-to-line-amp interconnects. I imagine the pile of interconnects cost more than any two or three of the amps!

All the Darling amps (some to a greater degree than others) were able to create a very convincing sense of instruments in space, and the music almost NEVER seemed to get stuck inside the speakers. Also, as a family trait, the Darlings were unfailingly musical with no listener fatigue or egregiously phony tonal balance that I could detect.

The single Darlings (one 1626 output tube per channel) definitely had volume "issues" in this setup (the 91-dB speakers were being asked to fill maybe a 12'x22' space.) The most noticeable challenges were sustained crescendos: playing them loud pooped the "singles" out dramatically. One listener thought this was a sign that the PS reservoir was too small.Larry might say that the pipe refilling it was too narrow. These are good directions for future refinements. The Darling amps, as a rule, do not always fare well on audio obstacle courses. They just play music.



Some listeners were very enthusiastic about the original, octagonal Darling. A few people thought this amp had the best sound of the day (when run within its limits.) This amp was also put forth as a terrific candidate for the top of a biamp setup, which it is. Betcha can't build just one!

"For me, the best of the single-single-ended class was the"Sakuma Darling" (1626 driving 1626, with transformer coupling at the input, between stages, and at the output.) This amp had a good combination of quality and quantity of sound, and it overloaded more gracefully than its classmates. I liked this amp both in the "fest" setup and in a pre-trial at home.

It painted a fine image, and it reproduced music with a pleasing sense of coherence and weight, but I did sense there was some "overhang" on transients. This may have been an artifact of ringing transformers. Bob thinks this can be remedied by applying some rocket-science to the trannies' secondary loads, and if so, this amp could be a big winner.

Certainly my IT-coupled amps were not in this class, despite the fact that they used many of the same parts. Cheapskates, rest assured these are the under-$15 sort of interstages, not the over-$150 sort."

My two double Darlings (2 x 1626 per channel) fared very well in regard to volume and a sense of weight, but some listeners noticed a decrease in the precision of the imaging with these amps, a little smearing in the treble as it was described to me. (We had several very good listeners and they weren't shy!)

The DC versions of both the single and double Darlings were, to my ears, much better than the cap-coupled versions in all respects. I am lucky to be a neighbor of Don Garber's (he's the manufacturer of the awesome Fi line of SET amps) and his enthusiastic endorsement of DC coupling was what led me to try this in a Darling-style amp. Bob's little "problem" is what led to his experiments, I think. (The DC Double Darling has the Fender "Champ" guitar amp output transformers, but almost all the rest of the amps used Hammond 125E's. Another variable.)

Larry Moore's wrinkle was a convertible Darling amp, which was suited for either a single 1626 or 12V6 (12V version of the 6V6 beam power tube, here triode connected) as the output tube. The 12V6's were slightly more powerful, slightly more "accurate" sounding, but maybe not as lush. Our quick comparison was not enough for me to make up my mind, the difference seemed subtle to me. I want to do some more listening with this amp Larry is pretty clear that he likes the 12V6 setup better.

The bug up Larry's ass is lowering power supply impedance; to that end, his amp,

1626

TRANSMITTING TRIODE

For oscillator applications requiring unusually stable characteristics

Heater°	Coated Unipotential Cathode	
Voltage	12.6	a-c or d-c volts
Current	0.25	amp.
Amplification Factor	5	
Direct Interelectrode Capacitances:		
Grid to Plate	4.4	μμf
Grid to Cathode	3.2	μμf
Plate to Cathode	3.4	μμf
Maximum Overall Length		4-1/8"
Maximum Seated Height		3-9/16"
Maximum Diameter		1-9/16"
Bulb		ST-12
Base	Small Shell Octal 8-Pin, MICANOL*	

MAXIMUM CCS RATINGS and TYPICAL OPERATING CONDITIONS

CCS = Continuous Commercial Service

R-F POWER AMPLIFIER & OSCILLATOR - Class C Telegraphy

Key-down conditions per tube without modulation ##

D-C Plate Voltage	250 max.	volts
D-C Grid Voltage	-150 max.	volts
D-C Plate Current	25 max.	ma.
D-C Grid Current	8 max.	ma.
Plate Input	6.25 max.	watts
Plate Dissipation	5 max.	watts
Typical Operation:		
D-C Plate Voltage	250	volts
D-C Grid Voltage*	-70	volts
	14000	ohms
	2300	ohms
Peak R-F Grid Voltage	105	volts
D-C Plate Current	25	ma.
D-C Grid Current**	5 approx.	ma.
Driving Power**	0.5 approx.	watt
Power Output	4 approx.	watts

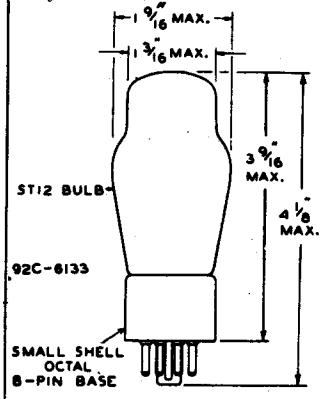
° In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.

Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

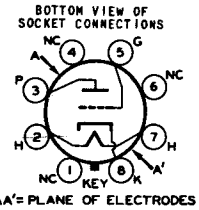
* Obtained from fixed supply (-70), by grid resistor (14000), or cathode resistor (233), or by combination methods. When the 1626 is used in the final amplifier or a preceding stage of a transmitter designed for break-in operation and oscillator keying, a small amount of fixed bias must be used to maintain the plate current at a low value. With plate volts of 250, a fixed bias of at least -35 volts must be used.

** Subject to wide variations as explained on sheet TRANS. TUBE RATINGS.

Registered trademark.



Data on operating frequencies for the 1626 are given on the sheet TRANS. TUBE RATINGS vs FREQUENCY.



AA' = PLANE OF ELECTRODES

Pin 1 - No Connection
Pin 2 - Heater
Pin 3 - Plate
Pin 4 - No Connection
Pin 5 - Grid
Pin 6 - No Connection
Pin 7 - Heater
Pin 8 - Cathode

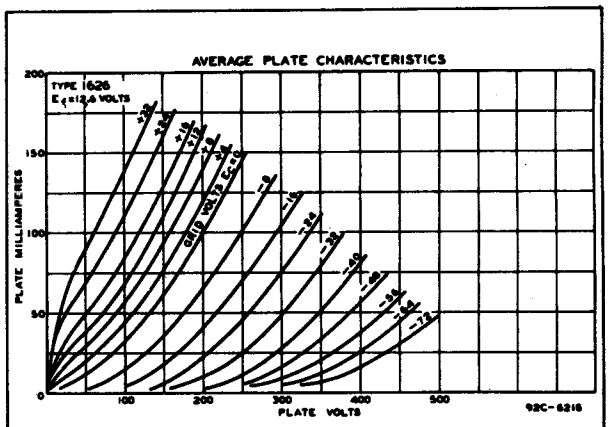
TUBE MOUNTING POSITION
VERTICAL or HORIZONTAL

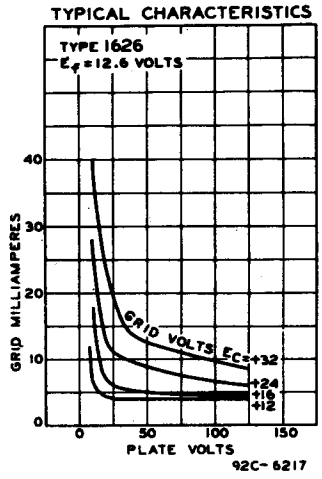
MARCH 15, 1941 TENTATIVE DATA

RCA RADIOTRON DIVISION
RCA MANUFACTURING COMPANY, INC.

1626

TRANSMITTING TRIODE





MARCH 15, 1941

RCA RADIOTRON DIVISION
RCA MANUFACTURING COMPANY, INC.

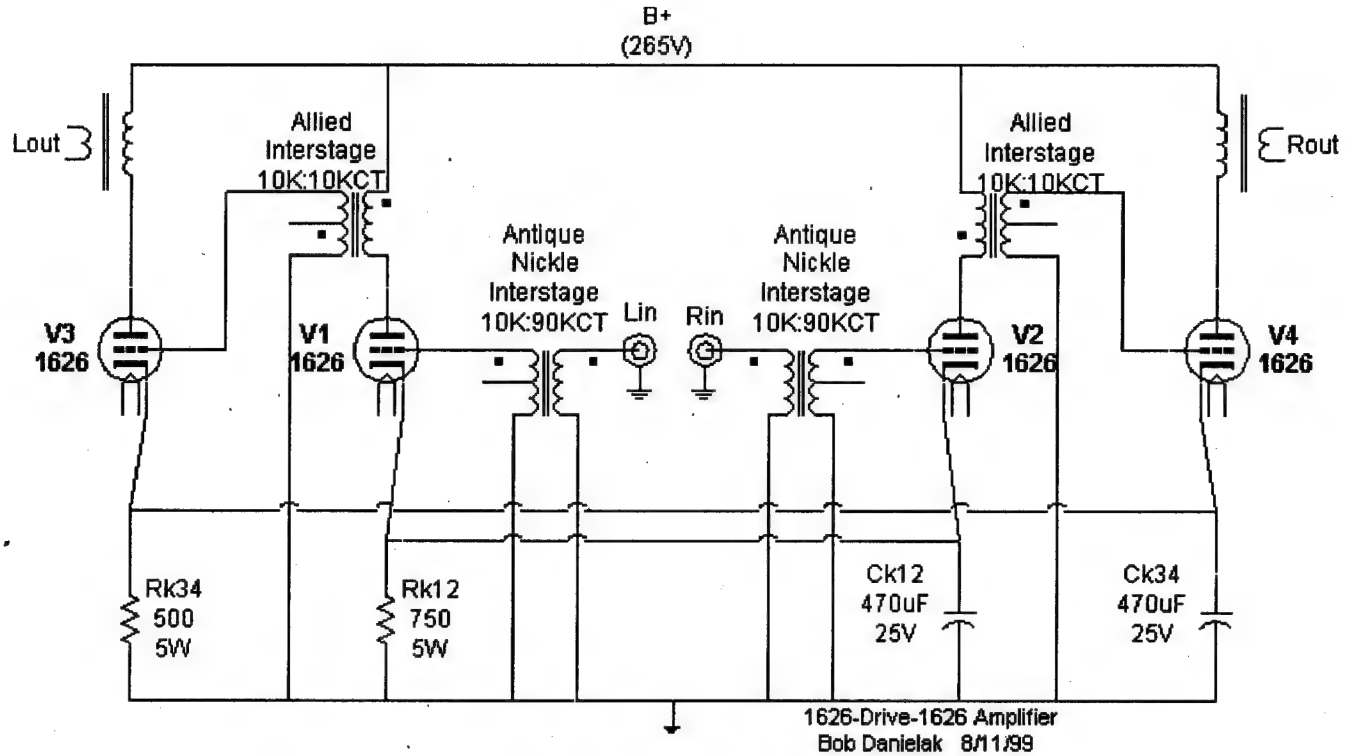
92C-6216, 92C-6217

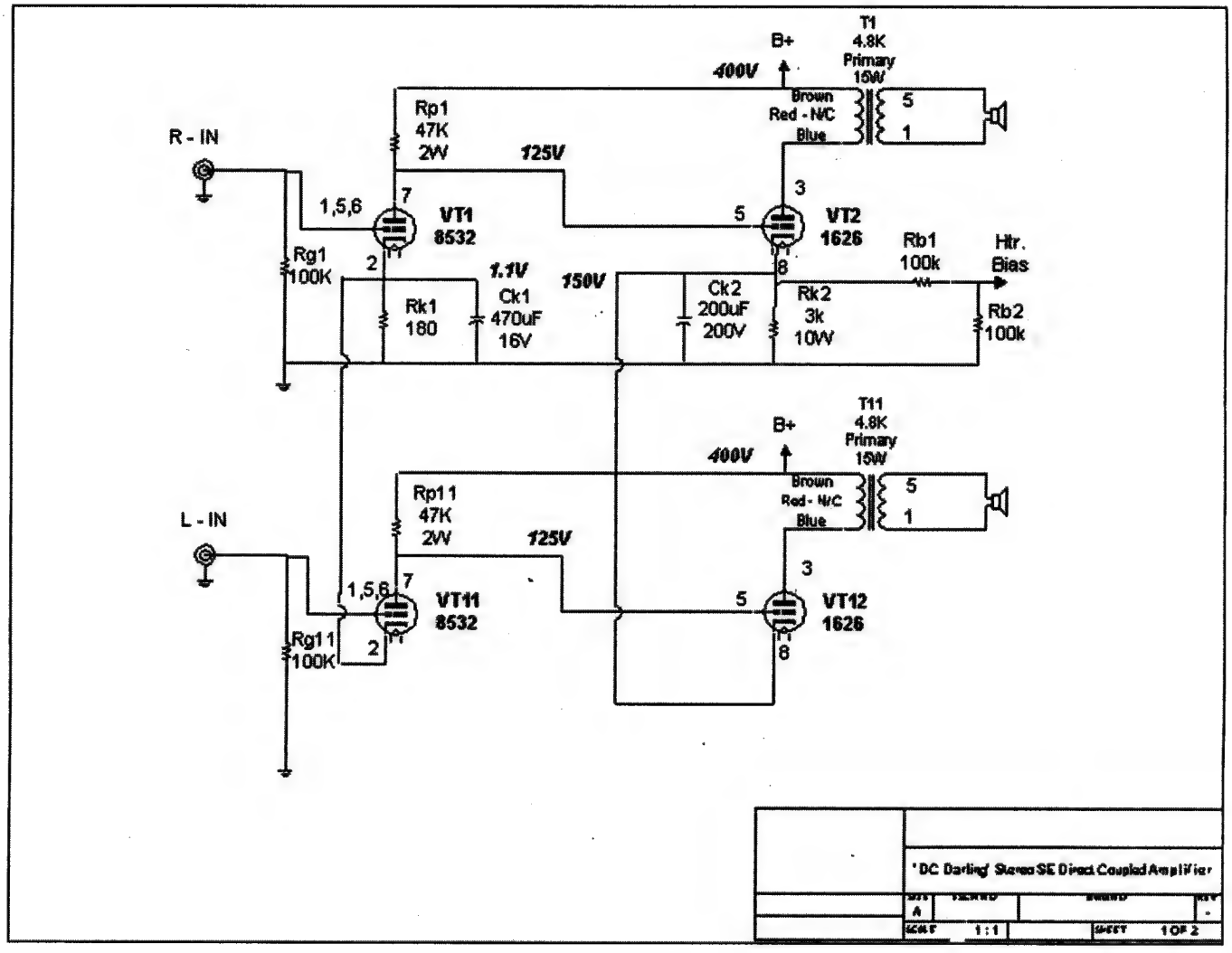
though small,nevertheless has dual,parallel, power transformers. It is a clear winner in terms of good looks: the amp features a gleaming copper top plate and surgically neat wiring below decks.

We auditioned a bold, noble experiment of Bob's, the Darling 3.5 :3 x 8532 driving 5 x 1626 per channel, using three parallel power trannies, developing 3.5 watts output. This amp was clearly the most powerful Darling, but there was definitely a diminishing-returns limit being reached : the amp had little of the delicacy and precision of the smaller amps, in fact it sounded a bit rough. This was despite the apparent top-end extension provided by a pair of classy One Electron UBT-1 output transformers.

I'd have liked to hear these trannies in another amp, but we had so many amps to audition, that we couldn't do all the clip-lead testing we wanted to do. There is material here for at least another day's listening, what with power supply variations and iron tasting and whatnot.. I wondered if this 3.5 model was perhaps fighting ultrasonic parasitic oscillations with its massively-parallel processing, and Bob wondered the same thing. Anyway, this design needs some more work before I would give it the go-ahead as a recommended project. At 3.5 Watts I would give the nod to a 2A3-based amp, which would be much simpler to build.The 3.5 was easily the most "psycho' DIY unit : 16 tubes is a lot to pile on top of a chassis, even one painted in a demented purple-with-white-polka-dots-and-black-blood-dripping-down color scheme. (MADD: Mothers Against Drunk DIY.)

The last Darling was actually housed in the chassis of Bob's first experimental model. It's now parafeeding some cool, octagonal UTC line matching transformers and uses a 12SL7 SRPP driver. The para-darling was popular but I myself had some reservations to me, this amp brought the music back into the speaker box much more than the others had done and its image had less depth to my ears. However, "Anna" thought the soundstage it threw up was particularly wide. It seemed to be about the equal of the


B+
(265V)
Lout
Allied
Interstage
10K:10KCT
Antique
Nickle
Interstage
10K:90KCT
Lin
Rin
Antique
Nickle
Interstage
10K:90KCT
Allied
Interstage
10K:10KCT
Rout
V3
1626
V1
1626
V2
1626
V4
1626
Rk34
500
5W
Rk12
750
5W
Ck12
470uF
25V
Ck34
470uF
25V
1626-Drive-1626 Amplifier
Bob Danielak 8/11/99


R - IN
L - IN
B+
400V
T1
4.8K
Primary
15W
Brown
Red - N/C
Blue
5
1
Rp1
47K
2W
125V
1,5,6
7
VT1
8532
2
Rg1
100K
Rk1
180
1.1V
Ck1
470uF
16V
150V
3
5
VT2
1626
8
Ck2
200uF
200V
Rk2
3k
10W
Rb1
100k
Htr.
Bias
Rb2
100k
T11
4.8K
Primary
15W
Rp11
47K
2W
VT11
8532
Rg11
100K
VT12
1626
'DC Darling' Stereo SE Direct Coupled Amplifier
SIZE
A
SCALE
1:1
SHEET
1 OF 2

Famous Guns



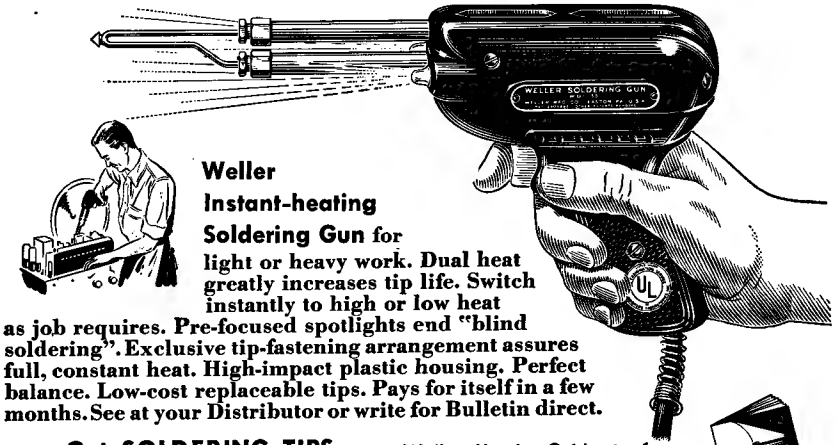


Deringer Percussion Pistol, Model 1843, product of Henry Deringer of Philadelphia. Deringer's large caliber, short barreled pocket pistols were so popular that others imitated them—calling them "derringers". John Wilkes Booth used a Deringer to assassinate Lincoln.





Trap or Doorjamb Pistol, Caliber .31, made by North & Couch, Middletown, Conn. This lethal little device protected householders against burglars. Fixed to the doorjamb, with a cord running from muzzle rod to door, the pistol fired all its barrels into any intruder.



Weller Instant-heating Soldering Gun for light or heavy work. Dual heat greatly increases tip life. Switch instantly to high or low heat as job requires. Pre-focused spotlights end "blind soldering". Exclusive tip-fastening arrangement assures full, constant heat. High-impact plastic housing. Perfect balance. Low-cost replaceable tips. Pays for itself in a few months. See at your Distributor or write for Bulletin direct.



Get SOLDERING TIPS, new Weller Handy Guide to faster, easier soldering. 20 pages fully illustrated. Price 10c at your Distributor or order direct.

Weller BETTER FROM GRIP TO TIP!

Sakuma-darling in its ability to play loud.

For dessert, I set up the DC-coupled 2A3 amp I recently finished, and it worked well to show what the Darlings did and didn't do well. My DC 2A3 is truly a child of the Internet: I got a nifty hum-reduction circuit from another e-mail pen-pal, Steve Bench, and used info about a "tuned choke" LC trap for the power supply which I gleaned from the rec.audio.tubes USENET newsgroup. I ordered parts from Angela Instruments' and Fair Radio's web sites, and e-pal Bob schmeered me with the Chinese 2A3's and the ceramic sockets for my Johnson—don't try that at high voltages!!

The 2A3 was clearly "big brother." I used AudioNote T-144 output transformers, which allowed for a bit more top and bottom extension as compared to the cheaper Hammonds and Champs. The 2A3 put out somewhat more power, but some of the Darlings imaged every bit as well as this sweet DHT, sounding just as liquid and as smooth. "Anna" had a sublime bit of software which sounded spectacular through this setup (it would have sounded transcendent through an AM radio, too): a 45-RPM test pressing of the Dallas Symphony playing Rachmaninoff's "Symphonic Dances For Orchestra," recorded in 1967, clearly using no compression and a simple signal chain. Wow!

I had been 5th row center at Avery Fisher Hall the night before and I think her system sounded better than a real event in some ways. Much better imaging—the recording is fairly dry which made for beautifully precise placement of instruments. The tonal balance was as close to perfect as I can recall hearing over a playback system.

Dynamically, well, at one point I just muttered, "Dang!" as the full orchestra hit a powerful accent, which sounded very crisp indeed.

(An aside : a personal highlight of that visit to Avery Fisher Hall was when I pointed to the photo of Mr. Fisher that graces the lobby, and asked my wife if she knew what he had done to amass the fortune that had made his philanthropy possible. The look on her face when I told her that he built tube amps was priceless.)

At the very end of the night, the diehards who were still left tried biamping the speakers. Our first attempt, with a Darling on top and a couple-hundred-watt BEL SS power amp on the bottom, didn't quite work.We had no means of balancing the two and of course the Darling played way

too loud for the BEL to keep up. (Yeah, right.)

We tried the Darling on top and the 2A3 on the bottom: this did balance better. But by the time we got to it, I was no longer capable of listening critically enough to say whether it was a step forward or not.

At that point we reluctantly decided to pack up and say our goodbyes. Our hostess with the mostest was misty-eyed to see us go without at least leaving her some gear to remember us by. As an event, it was a big success: one guy who had driven four hours to get there never lost the big grin on his face all day. There were some great hammer-and-tongs tech discussions, with plenty of new ideas to keep all of us busy for many months to come.

I find it very gratifying to get out of my workshop and off of my computer, and to meet some of my colleagues in the flesh :we have a lot of fun together, and it makes me feel like a little less of a geek.Or at least like a geek among geeks!

Here is a summary of the listening lineup, with some circuit details :

1) The original Darling (octagonal chassis, as seen in Sound Practices #15) : 8532 driver, 1626 final, Hammond 125E output transformers.

2) The red (evil twin of the green) Darling : same circuit but slightly different power supply.

3) The Double Darling : 6SN7 driver, 2 x 1626 final, 125E OPT's. 6BY5rectifier.

4) The convertible, copper-top Darling, set up as 8532 driving 1626, 125E OPT's. Dual power transformers in parallel.

5) The convertible, set up as 8532 driving 12V6.

6) The DC Darling (or "Monica" - it also goes around naked) 8532 DC coupled to 1626, 125E OPT's. The direct-coupled driver affords slightly more gain than the cap-coupled original Darling design.

7) The DC Double Darling (or "Leo" : Fender "Champ" OPT's, Fender

Stratocaster jack hardware) 8532 DC coupled to 2x 1626, "Champ" OPT's. 5AR4/GZ34 rectifier.

8) The "Darling 3.5." 3 x 8532 driver, 5 x 1626 final. Three parallel power transformers, One Electron UBT-1 OPT's.

9) Sakuma-Darling, AES "Nickel Wonder" IT in 3:1 step-up configuration -1626 - Allied 10K:10K interstage - 1626. 125E OPT's.

10) Para-Darling, 12SN7 SRPP driver, 1626 final, parallel fed to UTC line-matching trannies. Voltage doubler power supply.

That was it for the Darlings. Then :

11) DC 2A3 : 8532 DC-coupled to 2A3, AudioNote T-144 OPT's. 5AR4 rectifier, Steve Bench's hum-reduction diode circuit, "tuned choke" power supply filter.

12) Biamp, green evil twin top, BEL SS power amp bottom.

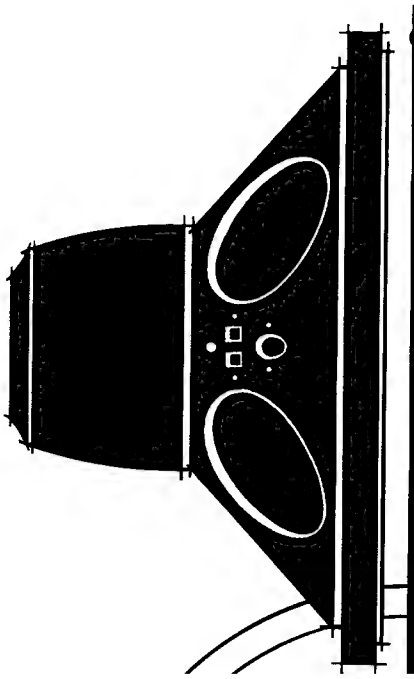
13) Biamp, octagonal Darling top, DC 2A3 bottom.

14) Green evil twin (identical to red evil twin.)

Quite a day!!

Thanks to Zelda at Clippy's 92-hour Photo Finishing for her assistance, to all the participants in the JoeNet for the ongoing education, and to Bob Danielak for being both way out in orbit and right down to earth.

We would all like to thank AnnaLogg and the NJAS for theirhospitality and for making this get-together such a success. See you at nyNoise 2000!"



A Homebrew HORN for TANNOY Dual Concentric Loudspeakers

by ROY HILSLEY

Reviving a 1960s classic...

I consider myself to be very lucky. My father introduced me to hi-fi when I was a teenager. That was over forty years ago! In those days audio electronics and hi-fi was very much an experimenter's hobby and my father loved to put electronic components together to make all manner of things. He built our amps, tuner and speakers—first for mono and then stereo. He even built our first TV set!

The early hi-fi shows in England were held at the Hotel Russell in London and we would visit to look, see and hear the latest audio innovations. My father was a music lover and could play the piano. He knew what sounded natural. At one of the shows he was so impressed with the sound made by one particular manufacturer that he ordered a pair of the speakers at the show. They were Lowther Acoustas (with PM6A magnets). These little gems were fast and very dynamic and we lived with them for several years but Dad always complained that they lacked really deep bass.

We fired them up with a Beam Echo pre-amp and a home brew Mullard 5-10 amp. This was a push pull EL84 ultra linear design. Great sounding design (based on the Leak Stereo 20) which he used with these speakers for several years until the Lowther surrounds deteriorated and he got fed up with adjusting the magnet to prevent periodic voice coil interference.

He was by then firmly committed to the sound of horns and he decided to try another approach using Tannoy dual concentric drive units. These very novel speakers have a horn loaded HF unit concentrically mounted within a large bass driver. They were made in three frame sizes: ten inch (called III LZ), twelve inch and a mighty fifteen inch unit and were supplied with a separate crossover. Tannoy units could be mounted in horn loaded or reflex cabinets and plans were available from Tannoy. My father bought two III LZ drivers for a horn loaded speaker project. Unfortunately, he never got 'round to building those speakers.

Many years passed and when I cleared out the old house, I came across these drivers and they captured my imagination. Those old units looked like new and yet were over 35 years old, but somehow the design looked right with the pepper pot drillings at the throat of the HF horn and the substantial cast frame.

I was at the start of the trail of audio simplicity and rebirth. I had owned typical hi-end British made transistor based hi-fi for many years and was listening to inefficient milti-driver speakers. They were, however, lifeless and had no



dynamics. Yes, I am sorry to say that I had become a victim of the press hype.

Dad had managed to collect all sorts of audio "junk" over the years and during the course of trading this at a vintage audio store in the UK I discovered that the industry was being revolutionized by the experimental amateurs again. Valves were back. Minimalist SE designs were advocated. Horns were being rediscovered. I discovered *Sound Practices*.

I started using a modern push pull valve amp for a while and then decided to build a pair of SE amps to my own design, 417A, 6J5GT transformer coupled to a VAIC 300B. Next came a home brew phono pre-amp (similar to the Siren Song) and what joy. The transition from high feedback transistor designs to no feedback valve designs revitalized my record collection and gave me so much more music and much more pleasure. The fun I had making changes then listening and making changes again.

After a while I became satisfied with the amps and I decided to try horn speakers. I started by trying a vintage pair of Lowther Acoustas. I loved the speed and life but soon became dissatisfied with the bass.

I decided to take up the project which my father had not managed to complete. I studied plans for the Acousta published in SP and I looked at the cross sectional plans of the well-respected Tannoy GRF enclosure published in old copies of Hi-Fi News. These designs gave me some ideas.

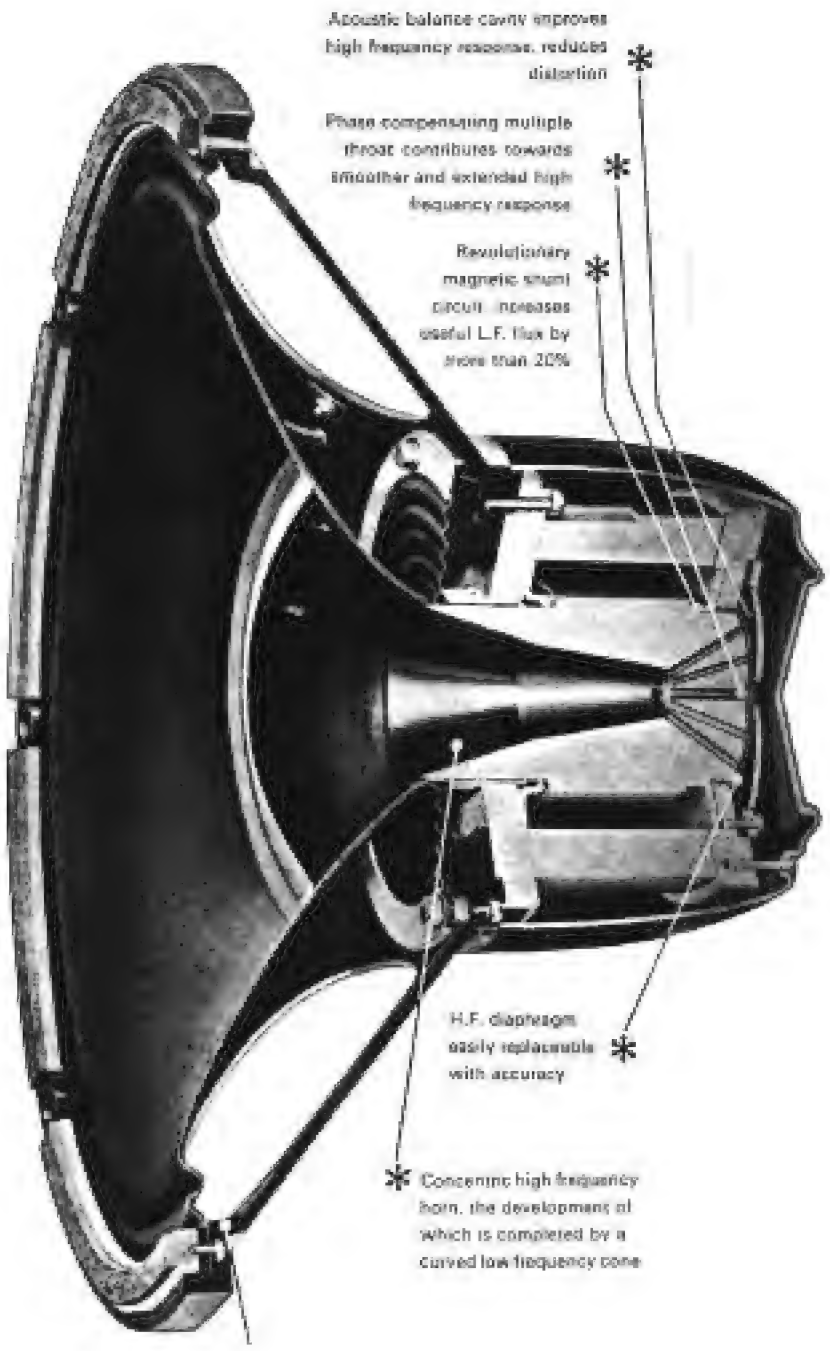
I wanted the efficiency and projection of horn loading, but with deeper bass, but I also wanted the cabinets to be dimensionally acceptable and wife friendly! The ideas crystallized into the cabinet shown in the photograph and illustrated in the sketch plans. The design is not theoretically founded on a particular horn flare. I adopted an empirical approach. I listened to, studied and measured other horns and based my design on what might look right and work. The plans are given as a basis for you to try a simple-to-build horn enclosure for Tannoy dual concentric units. You are free to experiment and improve or modify.

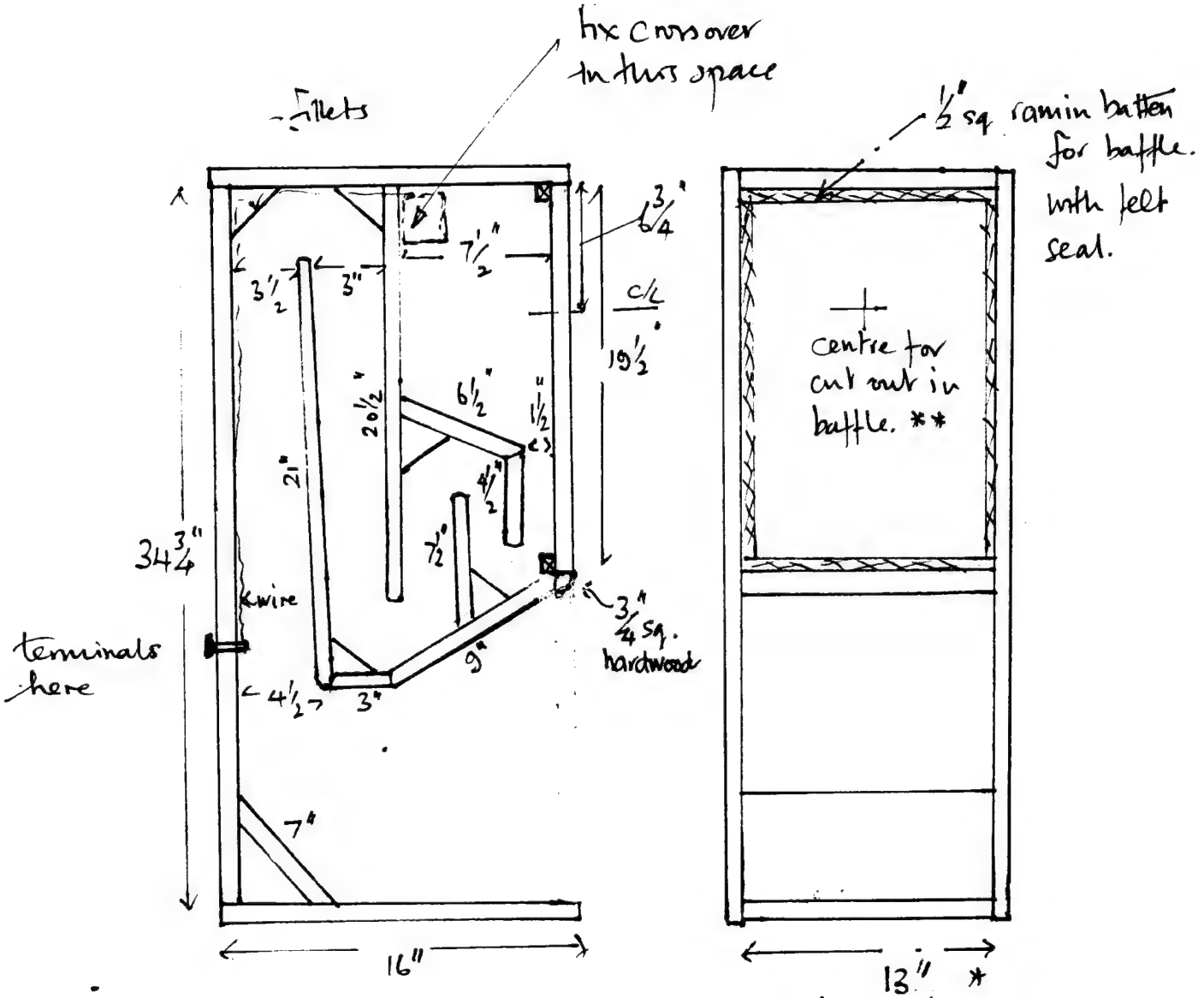
Cut the wood to the sizes shown. I used veneered plywood. There are two cabinet widths possible. One for the ten inch units and another for the twelve inch units. Assemble the top, bottom, rear and inner panels to a side panel. I used a "filler" type of fast-setting mastic glue. Do not glue the front baffle and remember to run internal speaker wires.

Make sure that the horn is airtight. Make the bass horn throat about half of the area of the bass cone. Glue liberally and smooth internal folds with glass paper (sand paper)as well as you can before you fix the second side panel. Make the front panel baffle airtight by using a gasket made of thin felt glued to the internal batten. Screw the baffle to the internal batten with about eight brass countersunk wood screws. Fit the crossover in the space shown on the plan. When construction is complete, sand down all external surfaces, oil and polish to suit.

When the glue is set and the polishing done fire them up—you will not be disappointed! You should be listening to deep tuneful bass with a solid image and good projection. The Tannoy HF horn will give you a clean midrange and top end projection. These speakers are efficient so you can drive them with your 10 watt or so valve amps.

In comparison to the Acoustas, you will hear deeper bass without the characteristic mild "honk" which I think the Lowther cabinets have. These Tannoy horn speakers have less of a "hot seat" stage as an added benefit. They are not particularly sensitive in respect of placement and I turn them in just a little and use them about a foot from the wall for best effect in my room.





* wide for 111LZ unit

$13\frac{3}{8}$"

* wide for 12" unit.

** cut out hole in baffle 9" ϕ for 111LZ
11" ϕ for 12"

Materials

Side panels = 18 mm

top, bottom, baffle = 14mm

internal = 12 mm.

all fillets = 4mm.

Plan for Homebrew Horn for Tannoy Dual Concentric Speakers

RWH Sept '98

Tannoy "Monitor Gold" Specifications

Frequency response	23—20,000 Hz.	25—20,000 Hz.	27—20,000 Hz
Polar Distribution for 60° inc. Angle	–4dB at 10,000 Hz.	–3dB at 10,000 Hz.	–2dB at 10,000 H.
Power Handling Capacity	50 watts*	30 watts*	15 watts*
Impedance Via Crossover Network	8 ohms (5 ohms min.)	8 ohms (5 ohms min.)	8 ohms (5 ohms min)
	"FIFTEEN"	**"TWELVE"**	**"IIILZ"**
Flux Density L.F. Gap	13,500 gauss	11,500 gauss	10,000 gauss
Flux Density H.F. Gap	18,000 gauss	15,000 gauss	15,000 gauss
H.F. Voice Coil Diameter	2″	2″	2″
L.F. Voice Coil Diameter	2″	2″	$2\frac{1}{2}$″
Intermodulation Products	less than 2%	less than 2%	less than 2%
Bass Resonance	26 Hz.	28 Hz.	30 Hz.
Magnet Assembly Weight	13 lb.	$7\frac{1}{2}$ lb.	$6\frac{1}{4}$ lb.
Magnet Material	Ticonal G	Ticonal G	Ticonal G
Crossover Frequency	1,000 Hz.	1,000 Hz.	1,200 Hz.
Overall Diameter of Frame	$15\frac{1}{4}$″	$12\frac{3}{8}$″	$12\frac{1}{32}$″
Overall Depth	9″	$7\frac{1}{2}$″	$6\frac{1}{2}$″
Fixing Holes P.C.D.	$14\frac{1}{2}$″	$11\frac{3}{4}$″	11″
Weight: (Crossover network & Switch panel as separate units)	21 lb. 13 ozs. (crossover 4 lb.)	12 lb. (crossover 4 lb.)	10 lb. 4 oz. (crossover $3\frac{1}{2}$ lb.)
Finish: Cover	High impact plastic	High impact plastic	High impact plastic
Frame	Stove enamel	Stove enamel	Stove enamel
Magnet Assembly Parts	Cadmium plate	Cadmium plate	Cadmium plate





Second-order Harmonic Distortion Cancellation in the SE Amplifier: Is it a sound practice?

by Ivan L. Johnston

...or is it distortion of distortion?

I've been struggling with this question since having first read about it in Glass Audio 4/96 (Harmonic Cancellation Improves the SE Amplifier).When I designed my PSE 845 Power Amplifier, I considered using second harmonic (H2) cancellation between the driver and output stages. Intuitively, increasing the distortion of any stage within an amplifier just did not sound like a good idea, and preliminary measurements during the prototyping of the first two stages confirmed my suspicions.

For those who are not aware of what I mean by H2 cancellation, I am referring to the practice of intentionally pre-distorting the signal at the driver stage, such that the second harmonic distortion that is produced by the output stage is canceled. You will find several articles in recent and not so recent issues of Glass Audio, touting the benefits of H2 cancellation (4/96: Harmonic Cancellation Improves the SE Amplifier, 5/96: A 15W SE Amplifier With 6C33C-B , 2/98: A Pspiced Preamp With THD Cancellation, 5/98: Canceling Harmonics in SE Amplifiers). The driver stage is typically either loaded down to increase the distortion, or the bias is intentionally mis-adjusted such that the H2 at the output of the amplifier is minimized. The distortion that is generated by the driver stage should most correctly be referred to as "complementary distortion",since it is simply the same form of distortion as that produced by the output stage, but out of phase. This should not be confused with inverse distortion, which is an entirely different subject.

Attempts to quantify the affects of H2 cancellation based on measurements made using real-world hardware have proven frustrating. It was easy to see what happens with a single test tone, but IMD tests indicated that there was what could best be described as a dirty noise floor over a large band of frequencies, which is difficult to quantify using traditional measurement techniques. Measurements are also limited by the dynamic range of the instrumentation, which for an HP3561A Signal Analyzer is about 80 dB. It has been suggested that distortion artifacts that are as much as 30 dB below the noise floor of an amplifier may have a significant influence on the perceived quality of sound produced by the amplifier.

In order to get a clear picture of what is going on beneath the noise floor, I decided to arithmetically model a simple two stage amplifier and analyze the results using various configurations for the driver stage. Rest assured, however, I will not be presenting a lot of complex equations involving high-order polynomials and Fourier analysis, the simulation model and the results are presented in a relatively easy to understand graphical form.

The model for each amplification stage is based on a polynomial. There are two coefficients in the polynomial that are adjusted as necessary to establish the desired amplitude of the H2 and H3 distortion products Real triodes also generate higher order harmonics, but I do not think that this will invalidate the model or the results, since the higher order distortion products generated by triodes are typically very low. I considered using a higher order polynomial, but I could not find any published data showing the relative amplitudes of the higher order distortion products for the 300B. The noise floor is artificially created using a random number generator to produce Gaussian white noise. The same seed value is used for the noise generator in each of the simulations, so the background noise floor is identical in each case. Each amplification stage provides unity gain, so this eliminates errors that could be attributed to different amounts of gain in successive stages. All in all, I consider this to be an optimum environment for exploring the potential of each system topology.

Figure 1 illustrates block diagrams of the two models that were analyzed, the Two-stage Amp With a Linear Driver and the Two-stage Amp Utilizing H2 Cancellation. The output stage is exactly the same in each model. The output stage models the characteristics of a 300B operated with 350V from plate to cathode, 60mA of standing current, and a 3K Ohm load impedance. This is your typical 8W 300B output stage. The distortion values

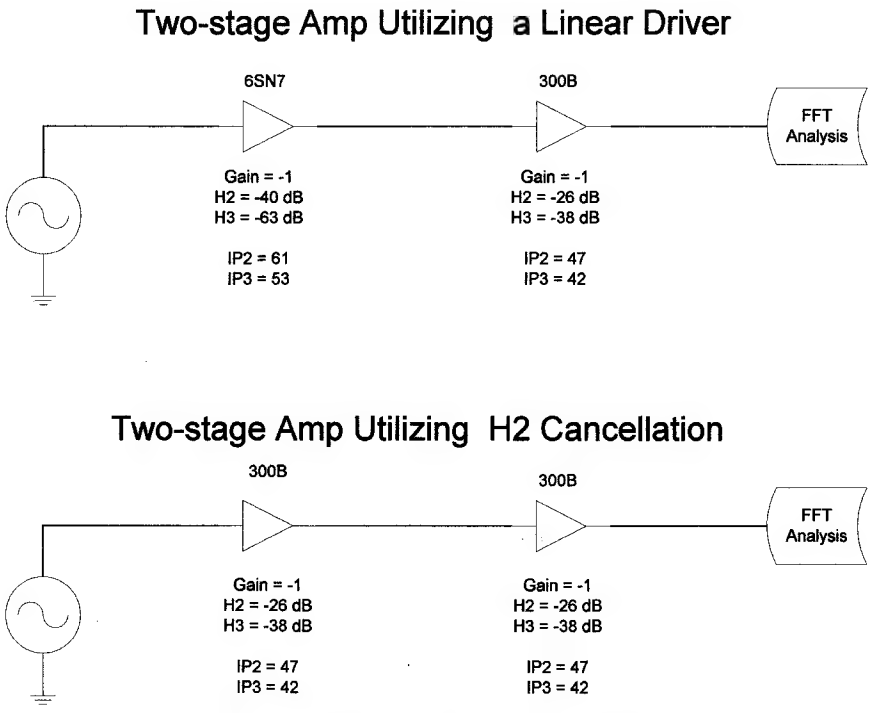


Figure 1— Block diagrams of models under analysis

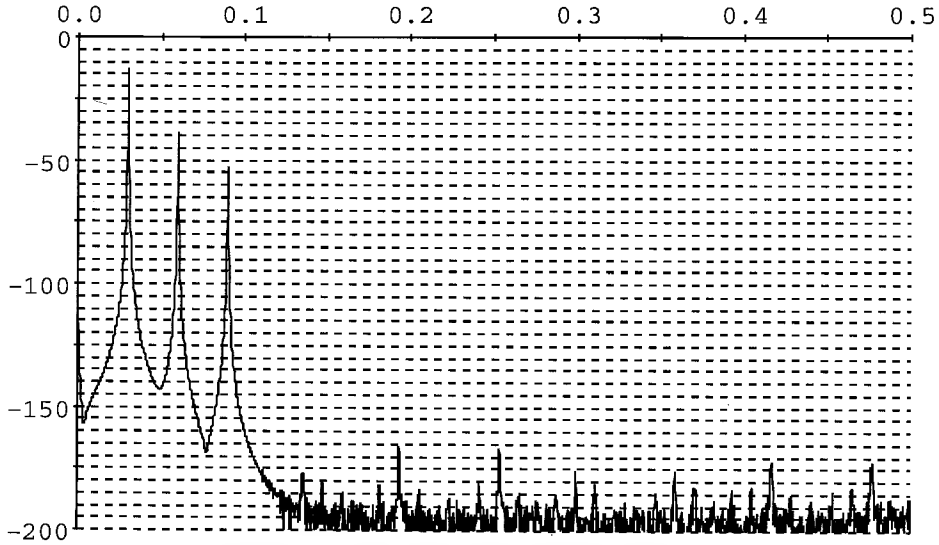


Figure 2— 300B, one tone sinusoidal input

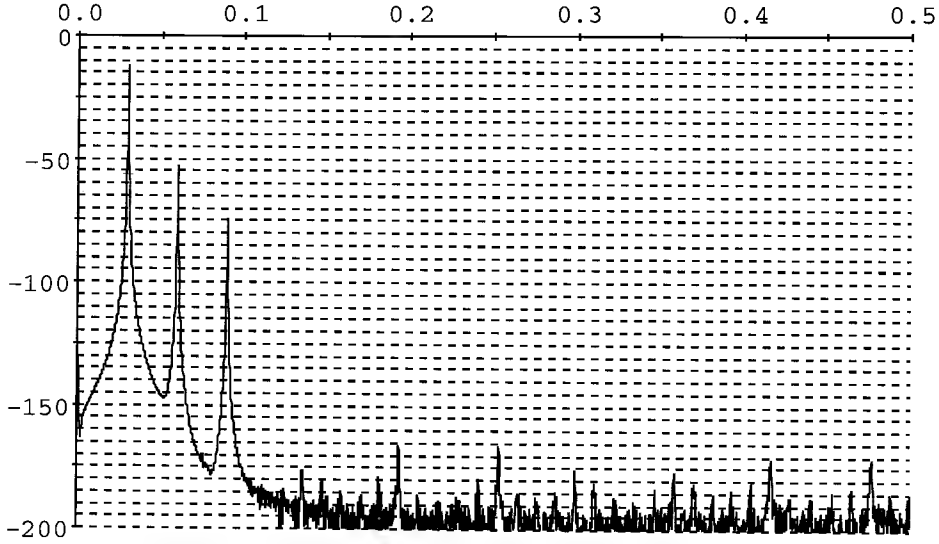


Figure 3— 6SN7driver, one tone sinusoidal input

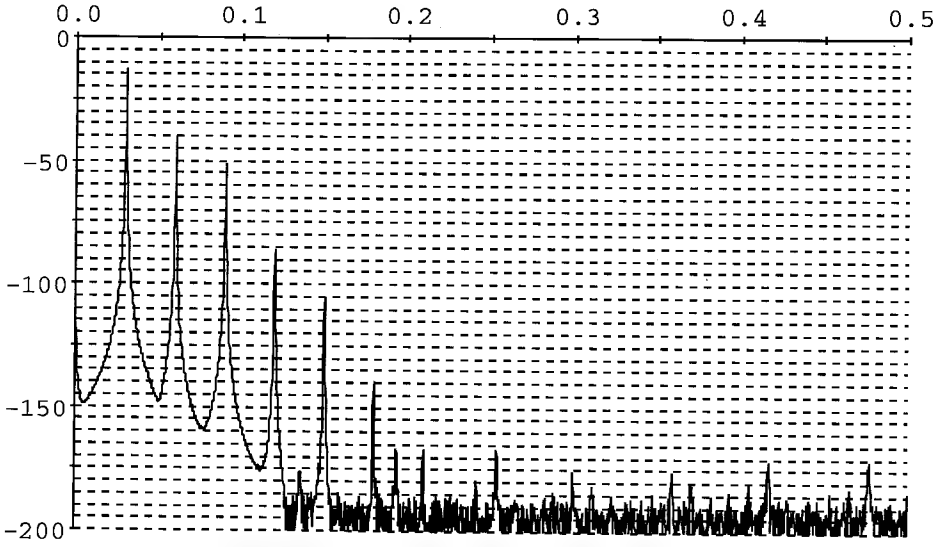


Figure 4— Two-stage amp , linear driver

(H2=–26dB and H3=–38dB) and operating points were taken directly from the Western Electric data sheets. Figure 2 illustrates the response of this stage, with a sinusoidal test signal applied to the input.

The driver stage for the first model simulates the characteristics of the 6SN7 used with transformer coupling and a cathode resistor bypass capacitor. The distortion figures for this stage (H2=–40dB, H3=–63dB) were taken from Lynn Olson's excellent article that appeared in Glass Audio 4/97 (Sound of the Machine: The Hidden Harmonics Behind THD),and represents the distortion of the driver stage at 50Vrms, which is just sufficient to drive the 300B output stage to full power. Figure 3 illustrates the distortion characteristics of this driver stage, again with a sinusoidal test signal applied to the input.

The driver stage for the second model, the model utilizing H2 Cancellation, utilizes the 300B model for both the driver and the output stage. This is representative of using a 300B to drive a 300B, with direct coupling and the exact same load impedance for both stages, the theoretical optimum application of complementary distortion.

The plots of the results were made by performing an 4096-point Fast-Fourier Transform (FFT) on the output of each model. I used a Hanning function to compensate for the bin spreading that results from the finite number of samples that are processed by the FFT, so the results are quite accurate. These plots are analogous to what you would see on a spectrum analyzer. The x-axis represents frequency relative to the sample rate, which in this case is 100kHz, so the x-axis value of 0.1 corresponds to 10 kHz.The y-axis represents the amplitude on a logarithmic scale, so the measurements are in decibels (dB) relative to an arbitrary reference.

Let us first examine what happens when a single tone is processed through these two different amplifier models. Figure 4 illustrates the spectrum of the output of the first amplifier model, with the linear driver stage, reproducing a single test tone. Notice that there are distortion products extending to the seventh harmonic. How can this be, the model of each amplifier stage only produces H2 and H3? The answer is simple, the H2 and H3 produced by the driver stage are turned into H4 and H6 in the output stage, and the H5 and H7 are intermodulation distortion (IMD) products. These higher order distortion products are literally "distortion of distortion." Figure 5 illustrates the

output of the model using the non-linear driver stage. As expected, you can see that the H2 level has been reduced approximately 25 dB. There is a price for this reduction in H2, however, note the large increase in the higher order harmonics. The H3 has been increased by 6 dB (6 dB is a doubling of the distortion!), the H4 has increased by 6 dB, the H5 has increased by 22 dB, the H6 has been increased by 34 dB, and the H7 has been increased by 42 dB.

Figure 6 and Figure 7 illustrate the results for the two models when simulating a two-tone intermodulation distortion test.Notice how the IMD products rapidly fall-off for the model using the linear driver stage. Close examination of the IMD products from the model using the non-linear driver stage, Figure 7, shows that there is suppression of some of the IMD products that are close-in,but again there are now IMD products that extend much higher in frequency.

Conclusion

I believe that Chapter 14 of the *Radiotron Designers Handbook* should be required reading for everyone involved in audio amplifier design. Langford-Smith discusses some studies performed by Olson and Shorter, in which it was found that the higher order harmonic distortion products should be weighted, in order to make these measurements correlate with subjective listening tests. Olson's study suggested a weighting factor in which the measurements for each harmonic should be multiplied by the harmonic number, while Shorter's results suggested that the measurements should be multiplied by the square of the weighting factor!

Clearly there is a price for the reduction in H2 that the cancellation technique provides. The third and higher order harmonic distortion products that are generated by the driver are additive to the third and higher order distortion products that are generated by the output stage. By directly additive, I mean that the percentage of each harmonic at the output of the amplifier (excluding the H2 component) is approximately the peak sum of the distortion produced by the driver and output stages, not the RMS sum.The THD (the sum of all the harmonics taken as a whole) is always the RMS value of all the harmonics, which is why you end up with a lower THD measurement when you cancel out the large H2 component.The IMD test results are more difficult to interpret,but it is fair to say that there are more IMD products generated when using the non-linear driver stage,

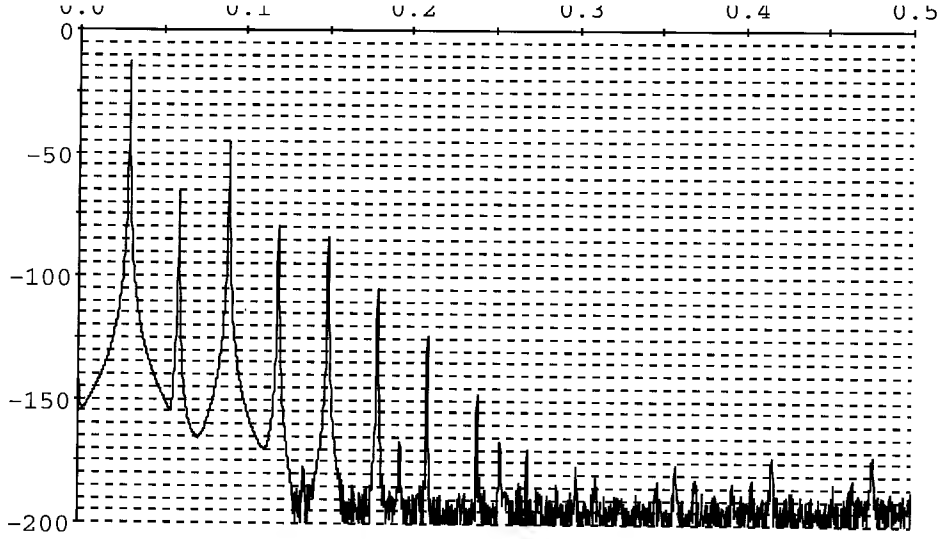


Figure 5— Two-stage amp, non-linear driver

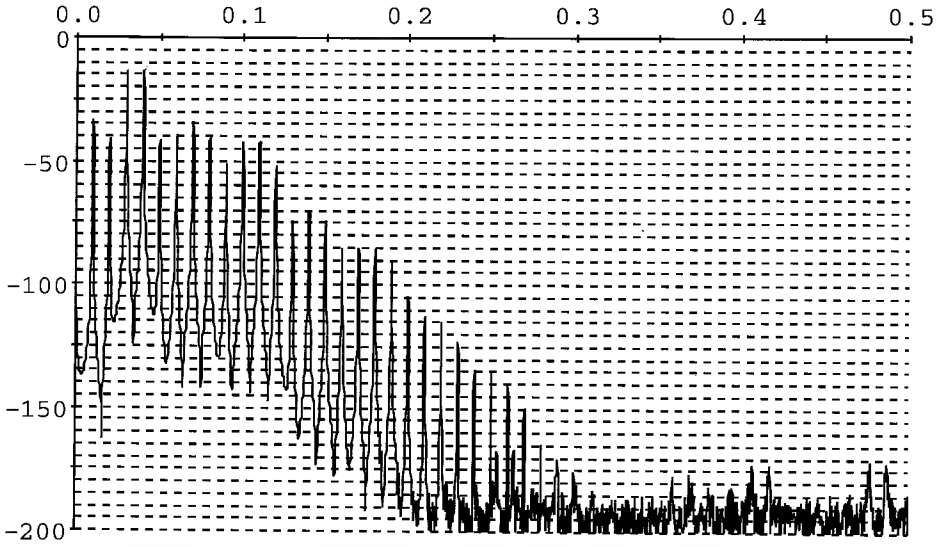


Figure 6— Two-stage amp, linear driver, two tone test

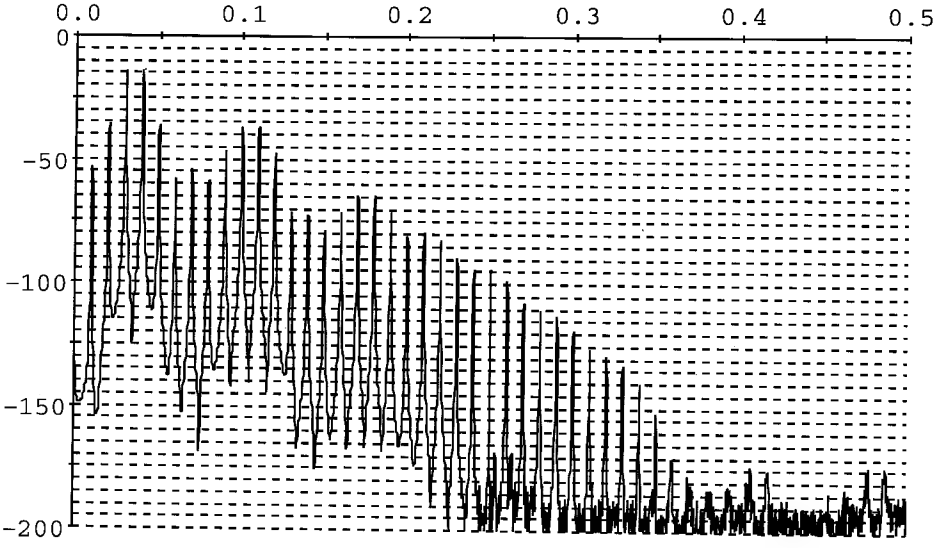


Figure 7— Two stage amp, non linear driver, two tone test

although there is a reduction in the amplitude for many of the close-in IMD products. To some extent, the IMD products are spread out over a larger frequency band when the non-linear driver stage is used.

Ultimately, each of us must choose what sounds best,as that is the bottom line. I have experimented with H2 cancellation using my own hardware, using test equipment to setup the driver stage with enough distortion to cancel the H2 at the output of the amp. It is very satisfying to achieve extremely low THD measurements with a single-ended design without using negative feedback, but are we measuring the right thing? After critical listening, I have concluded that for my ears, in the context of my system, a linear driver stage sounds better, despite the higher measured THD. I find that the difference is most notable when reproducing piano music and female vocalists. With a linear driver stage, the notes of the piano smoothly decay into a black background. When the highly non-linear driver stage is used, there is an edge of graininess that is clearly audible as the piano notes decay. There seems to be less space between the individual notes. The sound of some female vocalists can change significantly, to me there seems to be an edge added to some voices when the non-linear driver stage is used. Do not take my word for this, listen for yourself. I have always subscribed to the theory that SE amplifiers sound good in spite of the high levels of low order distortion, not because of them.This leads me to conclude that the reason they sound so good is the relative absence of high order distortion products. If this premise is wrong, if SE amplifiers sound good because of high levels of euphonic H2 distortion, it could be that the change for the worse is the result of the reduction in H2,and not the increase in the higher order distortion products. Since the reduction in H2 is accompanied by an increase in the higher order distortion products when the H2 cancellation technique is utilized, it is impossible to isolate the effects.

The popularity of the single-ended triode amplifier, without negative feedback, is in my opinion largely due to the fact that there is no substitute for linearity at the device level. The concept is simple, build the amplifier using the most linear devices available, and use those devices in circuits that extract the full potential of those devices, eliminating the need for negative feedback. The current trend of using distortion cancellation,intentionally increasing the distortion at the driver stage, is very disturbing. In my opinion, those who are touting the benefits of distortion cancellation in SE amplifiers have gone full-circle. They have resorted to techniques that result in low THD measurements, for specsmanship, at the expense of musicality.

About the Author :

Ivan has over 20 years of experience working with electronics. He is presently a Senior Engineer at Interstate Electronics Corporation, Anaheim CA, where he designs signal processing hardware and software that is used in military Global Positioning System (GPS) satellite receivers, and missile tracking systems. In his spare time, Ivan designs and hand-crafts custom preamplifiers and power amplifiers, and he regularly gets out to listen to live jazz at various venues in Southern California.You may contact Ivan at the following address:

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Caligula Incarnate!

Burning down the house with PP Parallel 6080s

by Jim Carlyle of Auckland, NZ

...Or was that Nero?

The mad emperor! Or was I just mad to build it? You be the judge. For $NZ1100 (US$550) I have a 4W/25W 80lb all-triode, genuine class-A, zero-feedback highly-resolving amplifier. And the 4 watt mode drives 86db/Watt Magneplanar MGIIIa's (tri-wired) in my 24' x 16' x 8-1/2' room just great. Use the 25 watt mode for a real blast. Impossible? The secret? Well, the sixteen output triodes slide into class AB, then AB2, then B as you crank it. Disgusting? Actually overload is extremely gradual on music, although 4W/25W is all you get on a sine wave test.

Forget about 845's, 300B's, 2A3's, 10's. Buy a dozen same-brand 6080's for $60 (total, not each!) and select eight so that two pairs give similar totals (left side push and pull) and the other two pairs give their totals similar (right side push and pull). This tube is the lowest mu triode in the universe (mu = 2) which results in the hugest available peak plate current swing without needing grid current. Say good-bye to driver transformers, low grid circuit impedance, class A2, and Miller Effect. Welcome in low plate impedance and high intrinsic speaker damping.

Problems? Yes, there are. Two in fact. First, these triodes have such low impedance that some specimens act like diodes, and start thermal runaway under fixed bias in 25W mode, when new. Put them aside out of your dozen. Secondly, these triodes need HIGH voltage grid drive. Feed your driver 6SN7's around 600 to 800 volts from a slow-turn-on 5AR4 FWBR with silicon diodes on the earth legs. Easy. Safe. Cheap. Effective.

Do I see heads shaking: "what about linearity?," meaning even spacing of plate current curves. Few people know that the 1950 RCA Tube Manual included a class-A zero-feedback 6AS7 circuit, with distortion versus power curve showing 2% at full power!

Do I hear, "what about single-ended mellow?" Having built amps and speakers since 1958, and passed a B.Sc. Radiophysics, and bought a 300B SE II with oil caps on Broadway New York in 1997, I can assure the fanatics that S.E.'s magic is simply gobs of 2nd harmonic distortion totally masking digital nasty distortion. Yes, MASKING is a deeply-researched phenomenon. The SE 300Bs lasted two days with me. Sure they made all sources sound inoffensive, but I prefer to hear all the detail. Oops. Honey, the editor just canned the article.

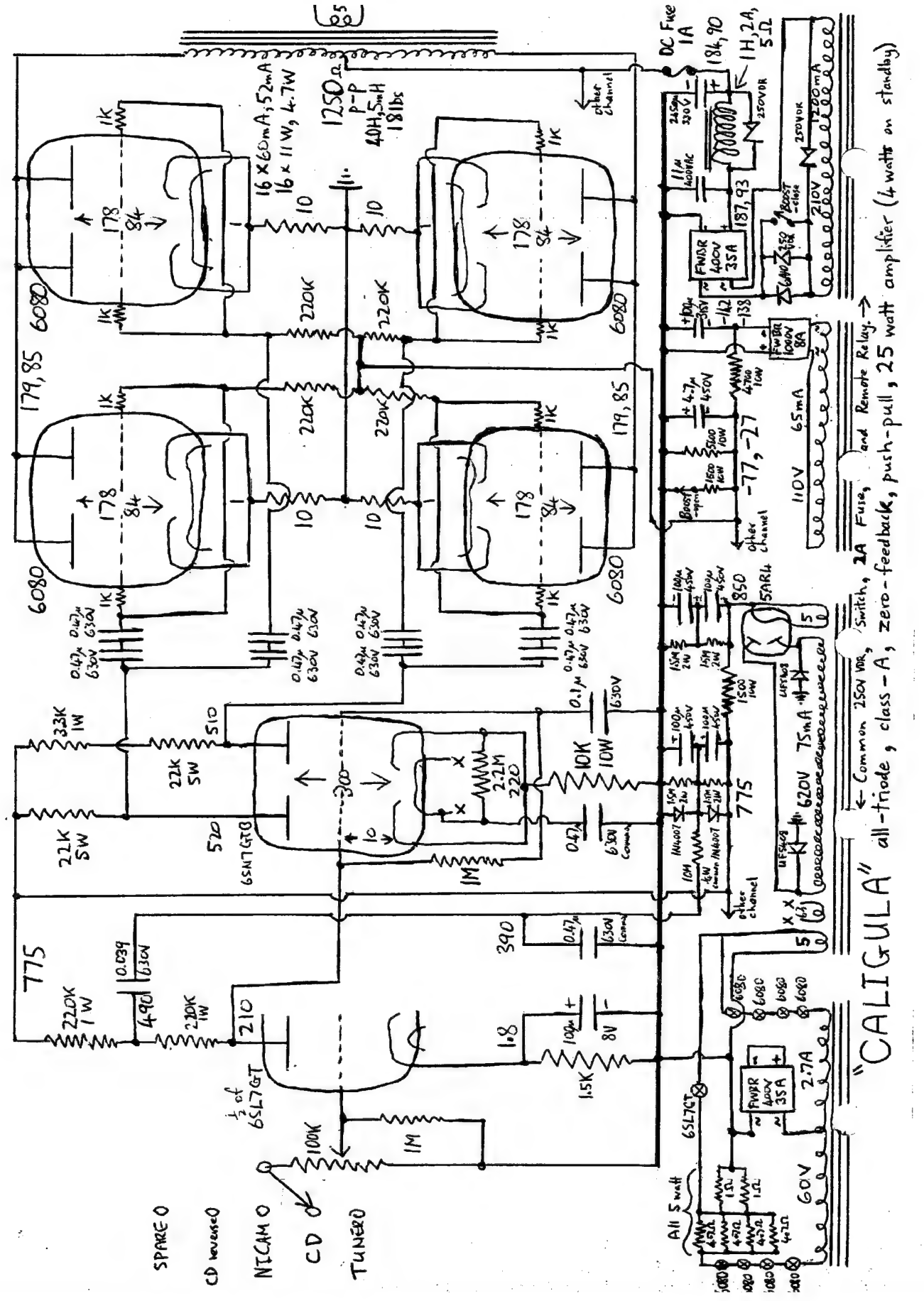


Here in Auckland (pop. 1 million), New Zealand's largest city, I have been selling amps and amp kitsets on a modest scale. So far every visitor to audition has purchased one of my range, mostly using 6AS7/6080. My amps are named Minuet (6BX7), Sentinel, Chimera (EL84 ultralinear), Pizzo (807), Skyline, Bravura and Caligula (top model). But this article is free for non-commercial use. It's not so special anyway, but, as Don Garber of "Fi" says about his 2A3 amps (and I visited him in Brooklyn),"none have come back yet."

The basic circuit is simple, having only one capacitor position in the signal path. The 10Ω cathode resistors allow current checking by voltmeter probe if you ease the tubes half out for testing. Record the readings, do some arithmetic, then shuffle the tubes as described above. The power system looks a little dramatic, but is still minimalist. The bottom left 60VCT tranny plus resistors heats eight 6080 at 2.5 amps, with a shorted FWBR to restabilize it if one bank of 6080 is removed in scorching weather. Only remove circuit right bank.

A custom tranny of 50.4VCT would be simpler. The 6080 heaters are wired alternately around the chassis, so that deactivating four still leaves a push-pull stereo amp of half power in, say, severe summer heat. The unusual 6SL7 heater connection was simply expedient.

My main power tranny is a 230V/230V at 250W isolating unit, used backwards giving 210V output. The boost switch converts from half-wave choke input to FWBR choke input. Note that the 11uF paper capacitor (2x5.6) falls to zero voltage between pulses, effectively choke input...He must be mad...high signal slides the p.s.u. toward capacitor input causing the voltage to rise. Music sounds like about 10W/60W subjectively. During resting a 10uF electrolytic exploded, as expected. Must be paper/oil rated for 400V.A.C. to stand the high ripple.


"CALIGULA" all-triode, class-A; zero-feedback, push-pull, 25 watt amplifier (4 watts on standby)
← Common 250V VDR, Switch, 2A Fuse, and Remote Relay. →
DC Fuse 1A
1H, 2A, 5Ω
16 x 60mA, 52mA
16 x 11W, 4.7W
1250Ω P-P
40H, 5mH
181bs
6080
6SN7GTB
6SL7GT
775
179, 85
184, 90
187, 93
-77, -27
-142
-138
65mA
110V
210V
250V
620V 75mA
60V
2.7A
SPARE
CD reverse
NICAM
CD
TUNER
All Switch

Note also that the 6A10 diode has no reverse-recovery-ringing problem because the bridge diodes feed the choke positive current from ground after each pulse ends! Freaky eh? Current for nothing. The twin readings on the power amp circuit refer to boost, low settings respectively. Other power supply topologies could be used (e.g. 12.6V @ 10A for the heaters), but I found that anything over 200 volts caused too many tubes to go into thermal runaway on initial tests. Don't be scared off. If they are stable for three minutes when new and cold, they will never runaway later, because heat causes the supply voltage to drop slowly, even with a choke of only 5Ω cold. Simply measure all eight on "low", then put your probe on the highest one while switching to "boost". If the reading keeps rising beyond 1.6 volts (160mA through tube) then you have a runaway. The average should be about 20mA.

Note that the preamp/driver tranny rated at 310-0-310V full-wave at 125mA,like mine, but used as 620V full-wave bridge, derates to about 75mA as shown in the parts list.Also, a 5AR4 can take up to 1100 volts AC in bridge mode because the anodes do not swing negative.

Puzzled about the 0.039 capacitor? Don't ask. Just do it. It is my subtle 0.6db magic ingredient that helps give the selling sound. But there are no special quality capacitors or resistors here. Get your own.

The 18 lb. output transformers were a real saga.I visited Manhattan's Steve Berger representing Tango (Japan) and was shown some wonderful products. I visited Staten Island's Herb Reichert, who had just finished "The Feral Eye", and simply adores Tango. I also discussed an 1800 ohm to 8 ohm custom design with Jack Elliano of Electraprint Audio, Las Vegas, which would give me 1250 ohm to 5.5 ohm for the Maggies. Costs looked high when taking into account shipping to New Zealand.

I eventually realized that a local wiring guru here could do it provided I calculated the layers/gauge/turns/interleaving. Using the Radiotron Designer's Handbook 4th Edition, the design took a few hours trying wire gauges until everything fitted into the turns ratio, with no part-layers. Final amp performance is -1db at 6Hz and 16KHz.

You have to get down to 20Hz divided by your damping factor (3 in this amp),or your triodes start to suck big current before you reach 20Hz.A famous commercial product starts sucking at 60Hz.By 20Hz at full drive its 300B plate currents exceeded 140mA each, and climbing! Wimpy output transformers were the reason. It measured flat to 20Hz but sounded tuneless like a reflex speaker. Perhaps a later article could go more deeply into designing your own output trannies from the Radiotron charts and formulae. Size does matter.

Parts List for Caligula 6080 PPP

Hardwar e
22"x 13"x 24" chassis
Power lead and grommet
2 switches
Rotary switch
100k log ganged
2 knobs
4 RCA input panels
8 speaker posts
2 fuseholders
12 octal sockets
8 feet and screws
Wire, solid core
Coaxial cable

Transformers
210v@2.7A isolation trans
R-129 60V@2.7A
R-10 620V@75 mA,5V@3A, 6.3V@2A,5V@2A
R55 110V@65mA
Choke 1H@2A, 5Ω (mount with "I"s oriented toward the back of the chassis)
Outputs—1250Ω P-P to 5.5Ω,Pri L = 40H, Leakage=5 mH, PriR=47Ω, Weight=18lbs.
5 1/4 x 4.3/8 x 2 3/4" stack

Tubes/Diodes
6080 X 8
6SN7GTB X 2
6SL7
5AR4
FWBR 400V@35A X 2
FWBR 100V@8A
UFS408 X2
1N4007 X2
6A10
VDR 250V X 4

Resistors
1.5M@2W X 5
1M X 4
220k X 12
22k@5W X 4
10K@10W X 2
2.2k X 2
1500Ω@10W X 2
10Ω@1W X 8
10M@1/4W
1Ω@5W X 2
1.5k X 2
2.2M X 2
5600Ω@10W
4700Ω@10W
4.7Ω@5W X 4
1k@1/2W X 16

Capacitors
0.47µF/630V X 18
0.1µF/630V X 2
0.039µF/630V X 4
100µF/450V X 4
100µF/315V
100µF/8V X 2
2450µF/330V
4.7 µF/450V
5.6µF/400VAC Paper X 2

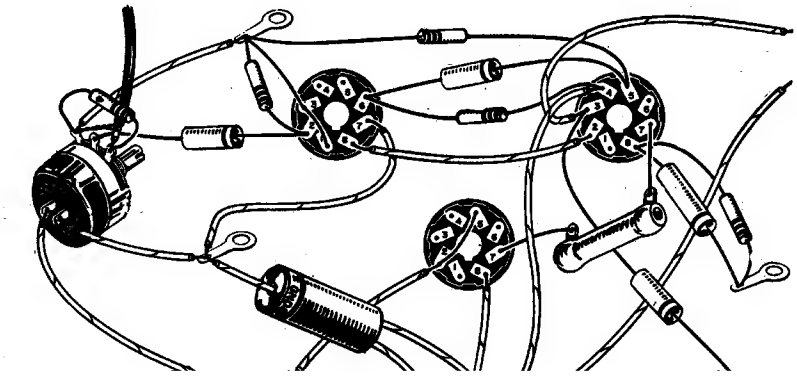
And now, saving the best 'til last: THE SOUND. Valve amps vary enormously, especially with zero feedback. This one is giving me stunning articulation of bass, highly resolved mids, and rather sparkly tops, certainly not recessed, but not too forward either. Customers like it,and so far the sales records 100%.What more can I say?

Notes on Circuit

Note that the 250VDR's prevent avalanche of the main rectifier during switching to "low". During bench testing, one punched-through to a dead short,caused by trying to switch off current through an inductor.



Note that the "boost"switch is "make"H.T., but "break" bias to be fail-safe in the event of a bad switch contact.This made the H.T. and bias time-constants impossible to match on both going-high and going-low. Do not increase the 4.7uF bias capacitor or your 6080's will briefly saturate when you switch to boost. Not healthy for emission.



SURROUNDED by TUBE SOUND

Part 1:The "Foz Reference" Phono Stage

by Jim Fosgate, Fosgate Research

The Foz built 100+ phono amps ... here are the two favorites

Many of you will be surprised to learn that I am a total "tube freak" as well as an audio professional. Tubes are where my heart is...I grew up on tubes working in my fathers Radio and TV repair shop in Indianapolis in the fifties. I remember building my own audio circuits back then with used parts, and circuits I found in Howard Sams *Photofacts*. My speakers were home made Jensen Imperials with Electrovoice drivers.

Like most people, I went "Solid State"when it came along. I remember wondering why my collection of records didn't sound as good as I thought they once did.I thought it was because my listening abilities had improved or my taste in music had somehow changed.

In the later Seventies, I invited a friend over to audition my system, a setup that I was quite proud of. This guy was a classical musician and tube listener. After listening for a while, his only comment was: "If you have a chance, you should listen to some tube equipment again." This stuck in my mind and one day at a garage sale, I found a Dyna Stereo 70, PAS Preamp, and FM-3 Tuner, for nine bucks, similar to ones I had once owned.The amp needed a 5AR4, and a fuse, but the tuner and preamp were working, so I decided to give them a listen.

I was really surprised! This old stuff was blowing my solid-state stuff away! My mind was boggled! My old records even sounded the way I remembered them. There was only one thing to do: sell all my solid state equipment,go back to tubes, and never look back again.

I started collecting old tube equipment, tubes, and parts when it was cheap to buy what most people thought was junk. I was afraid it was all going away, never to return again, and I wanted enough equipment to last a lifetime. I listened to many of these units and started building from circuits found in *Audio Amateur*, and other places. Back then it was necessary to use mostly used parts since today's tube renaissance had yet to occur.

I built about all of the classic circuits and then started rolling my own. I was glad when G lass Audio came along because there were more circuits to play with. I built many of them, as well as circuits I found in *Sound Practices* when it came out. It's sure nice to see the revival of tube equipment and the availability of high quality parts again. It's a blast to see the ratio of Solid State to Tube stuff at the Consumer Electronics Show, about 80% tubes the last few years.

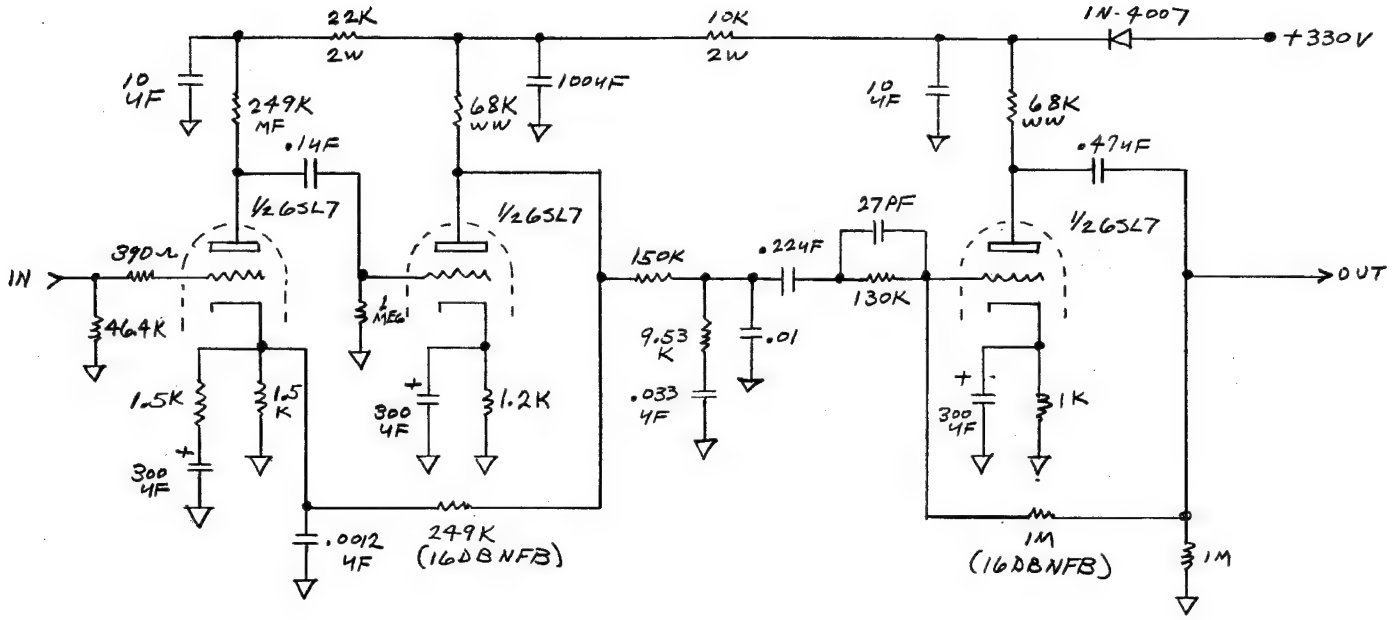
As part of my explorations, I built a pair of model WE 91 Single Ended 300B power amplifiers, which caused me to revise my ideas on the use of negative feedback.I tried several circuits with and without negative feedback to see what the relative benefits are. I found that the results can go either way, depending on the circuit and how the feedback is applied.One thing for sure, negative feedback is not a cure-all—sometimes the cure is worse than the disease, and it has been over-done more times than not. I believe that negative feedback can provide positive effects when properly applied to the correct circuit.

I realize that many SP readers feel that negative feedback is something to be avoided at all costs. To provide another point of view, I present the following three circuits, which I believe represent proper uses of the negative feedback concept,for your construction pleasure.

Keep in mind that negative feedback was always used to cut records. The stereo cutting head amplifiers have very effective motional negative feedback systems to cor-



The Foz chilling out in his well-appointed audio lab



PHONO PREAMP SIMILAR TO CITATION IV
10-10-99 JIM FOSGATE PASSIVE EQ, WITH FEEDBACK

rect nonlinearities in frequency response produced by the mechanical transducer. Cutting head armatures typically have a mass of several grams that must be accelerated up to hundreds of centimeters per second in a fraction of a millisecond, and this process may be repeated up to several thousand times a second.So, if negative feedback is a "totally bad thing," the record could not possibly sound as good as it does—no matter what we do in the phono preamp!

Two of these circuits are phono preamps, which represent one of the greater design challenges because of the low signal levels, the required 38db of RIAA equalization, cartridge loading problems, and so on. The other circuit is a simple line stage providing a low output impedance, without resorting to the conventional cathode follower topology.

What I want my system to do is "take me back to the original performance." Some of the circuits I've auditioned have a "sameness" in the sound that comes out on every recording—that is a coloration. I want to hear the recording, not a coloration.

Citation IV

Of all the phono sections I auditioned from the golden age period I liked the sound of the Citation Model Four best overall, even though it used fairly low cost parts in the stock unit. Stuart Hegeman designed this circuit in the late fifties, following his earlier Citation Model One. These preamps were the first designs I found that employing passive Phono EQ. Stu believed in ultra-wide-band-width and low distortion, he knew his circuits well and did some very fine design work.

I am presenting my modified version of this preamp. The original circuit used 12AX7 tubes. Through the years I have tried all brands of 12AX7s, but much prefer the sound of 6SL7s to 12AX7s. The 6SL7s are more microphonic but are very quiet, and sound oh....so....very...fine... in the midrange, maybe due in part to the round plates.

The JAN 6188 Phillips ECGs (military equivalent to the 6SL7s) are the quietest I've found. This preamp is unbelievably quiet for a tube circuit, (the quietest I've ever heard) and has enough gain to work with some of the low output moving coil cartridges. The use of 16db negative feedback around each amplifier stage provides greater definition from the 6SL7s than one might expect, probably due to the increased high frequency bandwidth.

The Foz Reference

The second phono preamp is my current reference unit. This circuit uses feedback equalization, but the equalization is split between two amplifier sections. Half of the RIAA equalization is accomplished in the first two stages with negative feedback.The other half of the equalization is accomplished in the last stage with negative feedback.

I have tried using single feedback EQ around two stages but I have not been able to "tame" the huge amount of feedback required for the RIAA equalization. Square waves always looked a little weird and the top end sounded strained. By dividing the EQ into two sections, we create a completely different animal.

A non-conventional three-position bass boost circuit is included as well, providing 3db or 5db of bass boost,and a flat position. The reason I put this in was because I have adjusted the tonal balance of my system for digital sources, and some of the older records sound a little bass thin in comparison to the digital material, but some are right on the mark. With the boost switch I can make them all sound the way I like 'em, but you may, of course, omit this function.

I used fixed bias in each stage, with the second and third stage bias obtained from batteries. I hear deeper, tighter bass with fixed bias, and the sound is more dynamic overall than with self-bias circuits.

I measured the output impedance one day and found that the impedance is about one

fourth that of a stage with an un-bypassed cathode bias resistor. We could of course bypass the resistor with a capacitor but it would need to be a several thousand microfarad cap to have the same effect, and capacitors that big usually don't sound all that good. The best cathode bypass capacitor is obviously going to be none at all.

The tube sounds better with the cathode grounded and the bias applied to the grid. The lower output impedance helps drive long cables or solid-state recorders without sonic degradation too. My turntable is mounted some distance from the line stage, requiring about 15 feet of cable. I found that the cable they sell at Wall Mart for the digital satellites under the RCA brand name, (RG 6) is low cost, low capacitance, and good sounding. You need a connector that crimps to the shield because the shields are not solderable. I use Tiffany RCA connectors which are a tight press fit.

For the bias batteries, I use three AA alkaline cells soldered directly into the circuit. AAA cells are OK if you do not have the room for the AAs. No need to use separate cells in each stage, but it won't hurt anything either. The battery life should be several years, probably equal to shelf life, because there is virtually no drain whether the circuit is on or off.

Line Stage

The third circuit pictured is the line stage that I'm presently using. It also uses fixed battery bias and negative feedback. I have seen this circuit called an anode-follower, which may or may not be technically correct. It provides low output impedance, and can drive long cables or a solid-state power amplifier (with an increase in the value of the output coupling capacitor value to about 1uf). With a 392k feedback resistor it measures 9.5db gain, and 2k output impedance. With a 1M feedback resistor it measures 15db gain, and 3.5k output impedance.

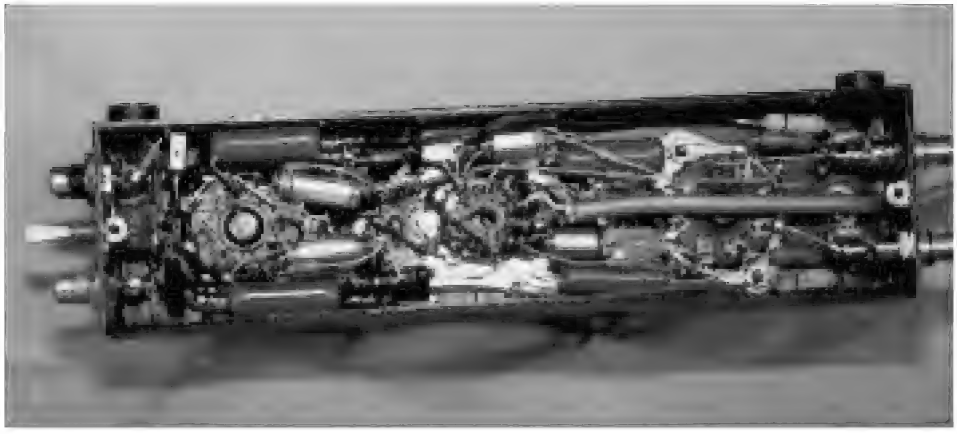
My longest cable run is to my left front channel amplifiers, about 50 feet. I measured about 835 PF on this RG6 cable, not bad for a cable of this length.The line stage drives it just fine. I like the sound much better than circuits that use cathode followers, not that cathode followers sound bad, they really don't—until you take them out of the circuit and hear the difference. They just sound better to me when they're gone. I can't figure out why, it doesn't make sense, but that's been my experience with them.

I have included a loudness control on the line stage that is bound to stir-up some con-



troversy. The volume pot I used is made by Alps, and sold by Radio Shack as part number 271-1732C for $1.99.A stepped attenuator is the way to go if you want the best possible sound, less grain,and better fidelity for sure on super sounding systems, but the "Alps" sounds pretty darn good, best control you'll ever find for two bucks.

As you undoubtedly guessed by now, I



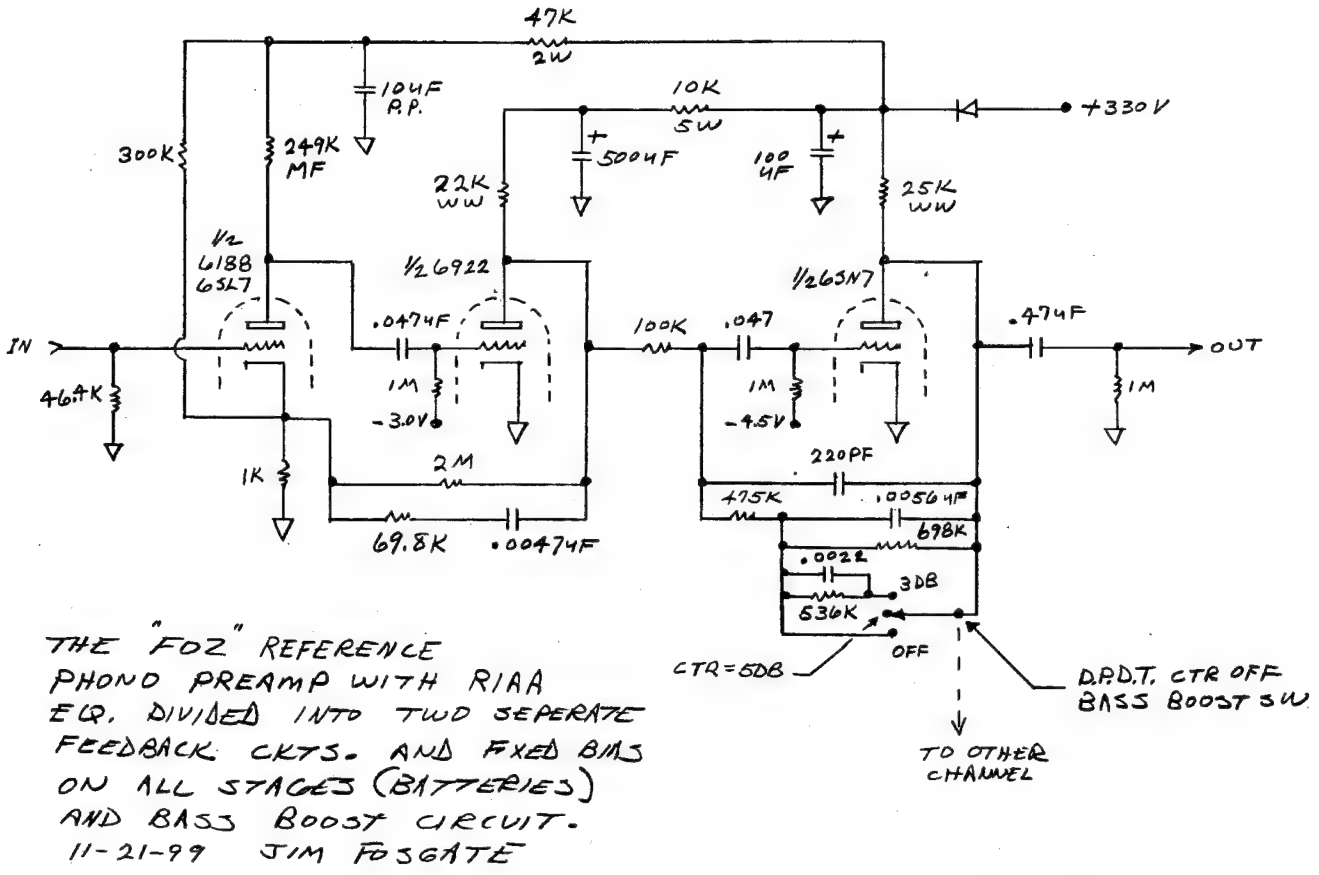
believe in loudness controls, especially for listening at fairly low sound levels. Long ago a couple of guys by the name of Fletcher and Munson did a lot of work analyzing how our ears work and published a family of curves that show how the frequency response of our ears falls off at lower sound pressure levels.

What the curves show is that if you play back a recorded performance at a considerably lower level than that at which it was recorded, it will sound like it does not have as much bass as it did at the live performance. Try this test yourself, turn the volume down and listen to the bass...falls off some doesn't it?

A good loudness control can cancel this effect out completely, so that the bass sounds about the same level as you turn the control down. It's very important to get the over all system gain right when using a loudness control,too much gain = too much bass boost too soon and it will sound bass heavy when you turn the level down. Too little gain = not enough bass boost soon enough and the bass will still sound like it is falling off at lower levels.

Change the 392K feedback resistor if you need to, until the bass balance stays about the same as you turn down the volume. (A larger value increases the gain;a lower value decreases the gain) Almost all of the early audio designers used loudness controls. Try one, you just might like it! The switch gives you the option of turning it off if you don't like the effect on a particular selection.

The quality of the parts affects the sound in

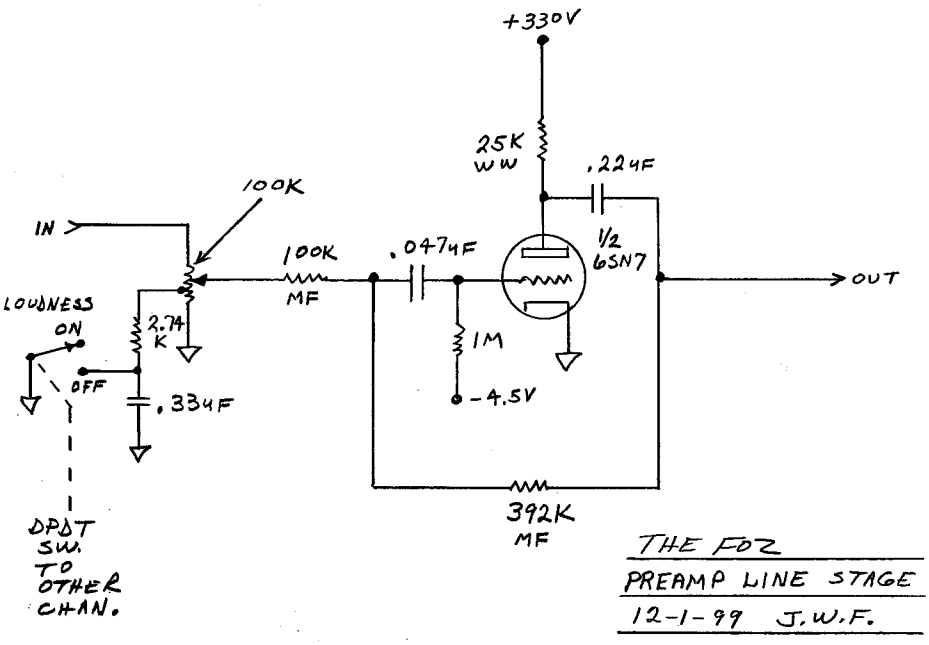




negative feedback circuits but probably to a lesser degree than non-feedback circuits. I use metal film resistors most places including the plate loads in the first stage of the phono preamps. I measured the input stage preamp noise floor at 7db lower with metal films than with an Allen-Bradley 240K 2 watt carbon resistor. The noise floor is low enough to use the AB if you are using a high output phono cartridge, but you will need a metal film or metal oxide for low output cartridges.

As far as tubes go, I use the Sovtek 6922 because they sound very smooth to me. Most 6SN7s sound good in these circuits. I was lucky to find some surplus 1942 vintage US Navy CTL 6SN7GTs with round plates. The guy I bought them from said they had been spares aboard US Navy ships during WW2. Talk about nostalgia, can you imagine listening through a tube that floated over the high seas during WW2! What a story they could tell us.

Layout and grounding have a very strong impact on the sound of any phono preamp. I build my cases using glass epoxy printed circuit board material, and do point-to-



point wiring using the copper case foil for the ground plain. The PC board material cost for a preamp would be about the same as a small chassis. I shear the material with a standard paper cutter, as found in office supply stores.

To make the box, I tape the pieces together and "tack solder" the edges with a soldering iron, next I run a bead of solder around all the seams and solder threaded standoffs for nuts to the bottom to hold the cover on. I drill holes for the bypass capacitors and stand them up. I use an Exacto knife to remove some foil to create a PC land to solder the leads to. After the case is sanded and painted it is the neatest little package of tube electronics I've come up with, and it sounds great too.

I believe in large filter capacitors in the 330v power supply. The output cap I use is usually about 500uf with a 10uf PP capacitor across it.The big cap gives super stable output voltage at low frequencies with rock solid bass, the 10uf PP bypass gives low impedance at the mid and higher frequencies, for a very smooth detailed top end.I do not like using small bypass capacitors across the electrolytic can sound funny sometimes.

Foz Reference System

You would probably get a kick out of my main reference system.My listening room is fairly large, 24 feet by 34 feet; with ten foot high ceiling, and about 45 people can be squeezed in for a demo.

The electronics consist of an all-tube five-channel tri-amplified surround system,with passive crossovers built into the amplifiers. The tweeter amplifiers are single ended at 6 watts each.The mid and bass amplifiers are push-pull at 55 watts each.There is no global feedback in the tweeter or midrange amplifiers, and about 12db negative feedback on the bass amplifiers. All the output tubes are EL 34s. Don't knock 'em, these amps will blow you away!

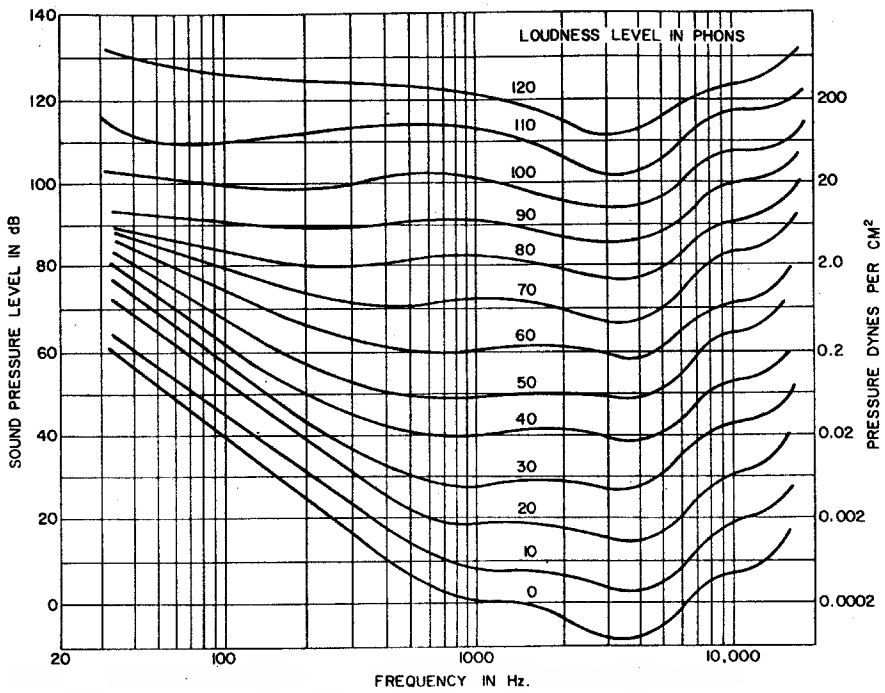
If you think it's a lot of work modifying two channels of amplifiers when you get a new idea, you should try modifying fifteen amplifier channels! I sure wouldn't need to go to the gym that day for a workout.

The surround processor incorporates a new "breakthrough" technology I have been working on. It converts the stereo signals into high separation surround,using six dual triodes for the complete audio path and solid-state circuits for the steering logic.

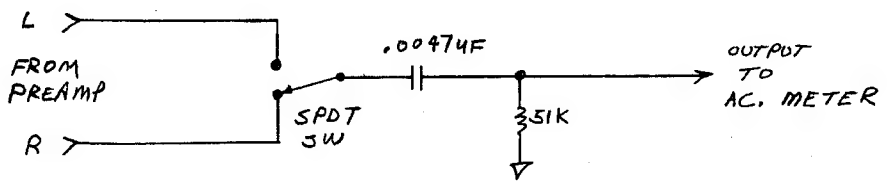
The turntable is a VPI-TNT 2 with an ET-2 air bearing tone arm.My current cartridge is the Audio Technica AT-440/OCC, available for around $100 retail from J&R Music World. This sleeper blows away all of my other cartridges, including some very expensive MCs!

One thing guaranteed to improve the performance of your phono system. is proper setup It is best to mount the preamp as close to the turntable as possible and connect directly to the wires coming from the arm if you can,or at least shorten the wires. I mount my preamp directly under the TNT-2 turntable and connect directly to the arm wires. My arm cable measures only 50 pf cable capacity.

The Audio Technica cartridge is happy with this load or up to about 100 pf, and with these preamps, it measures less than plus or minus 1/3 db deviation across the audio band on a CBS test record. It is best to load a low output moving coil cartridge right at the cartridge. I solder the load resistor directly to the clips that attach to the car-



The Fletcher-Munson curves,hearing data that the high-end industry forgot. Loudness compensation was a standard feature of quality vintage-era preamps.



SETUP TO MEASURE PHONO CARTRIDGE CROSSTALK
J.W.F. 12-3-99

tridge (do not solder to the cartridge terminals, the heat can ruin the cartridge).

If your arm has adjustable axial-tilt,it can be adjusted electronically to obtain equal separation across the channels (equal cross-talk). Due to production tolerances, most cartridges will not end up at exactly 90 degrees to the record and will "open up" when correctly adjusted. Connect the output of the preamp to an AC meter with the HPF filter and switch circuit shown. (The filter reduces the low frequency rumble so it does not affect the reading) Play a pink noise or 1khz signal on the left channel from a test record and read the cross talk in the right channel. Repeat the process for the other channel,play a right channel signal and read the cross talk in the left channel.The idea is to adjust the axial tilt for equal cross talk, usually 20db or better. Repeat the process as many times as it takes to get equal readings. If your cartridge must be tilted way off of the 90-degree position, it could be a defective unit.

My video projector is a ceiling mounted ten-foot diagonal. The speakers are flush mounted in the walls with oversize infinite baffling for the woofers. The corners of the room are all 45 degrees to control diffraction and resonances. There are four 10-inch woofers on each front channel and two on each back channel for a total of sixteen woofers.

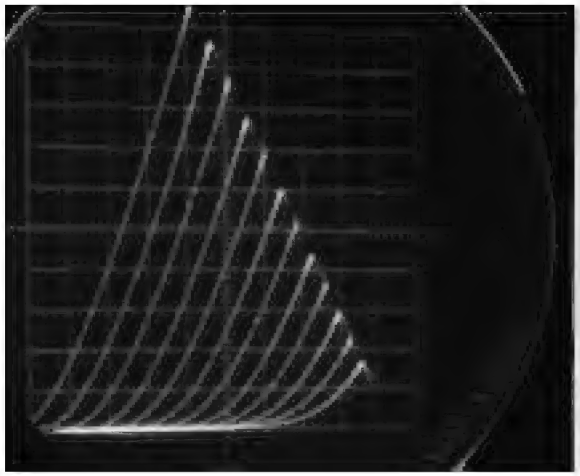
The mids are 5 1/8"aluminum cone drivers, two per channel. The tweeters are Vifa 1" horn loaded silk domes. The room is located in the basement far away from the bedroom and has concrete walls and ceiling. All I need is a generator and some food and I've got the perfect bomb shelter!

The ceiling is a suspended type with acoustical material above to create a bass trap. The walls are heavily carpeted for sound absorb-shun. I can listen in the middle of the night at "full throttle" without waking my wife or bothering the neighbors.

In the dark (which is of course the only way to listen), the glow of the tubes gives me a warm,nostalgic feeling. I am surrounded by thousands of records all around the room. The tubes provide enough heat to warm the room here at 6,000 feet in the Utah Mountains on the coldest winter nights. The system takes me just about anywhere I wish to go, truly a music lovers dream come true.

I hope you find something useful here. I've enjoyed writing this article, have fun.

Yours truly... The Foz



Adapting a Transistor Curve Tracer for Vacuum Tubes

by Alan Douglas

Playing with vacuum-tube curve tracers is fun and is at least as productive as building amplifiers. The bad news: there was only one commercial curve tracer, the Tektronix 570, and practically all of them are spoken for by now.

The good news: there are low-cost alternatives. Transistor curve tracers have always been more popular than tube models,

since transistor specs are so variable; in fact they are still very useful, especially for repair work where original replacement semiconductors are not available.

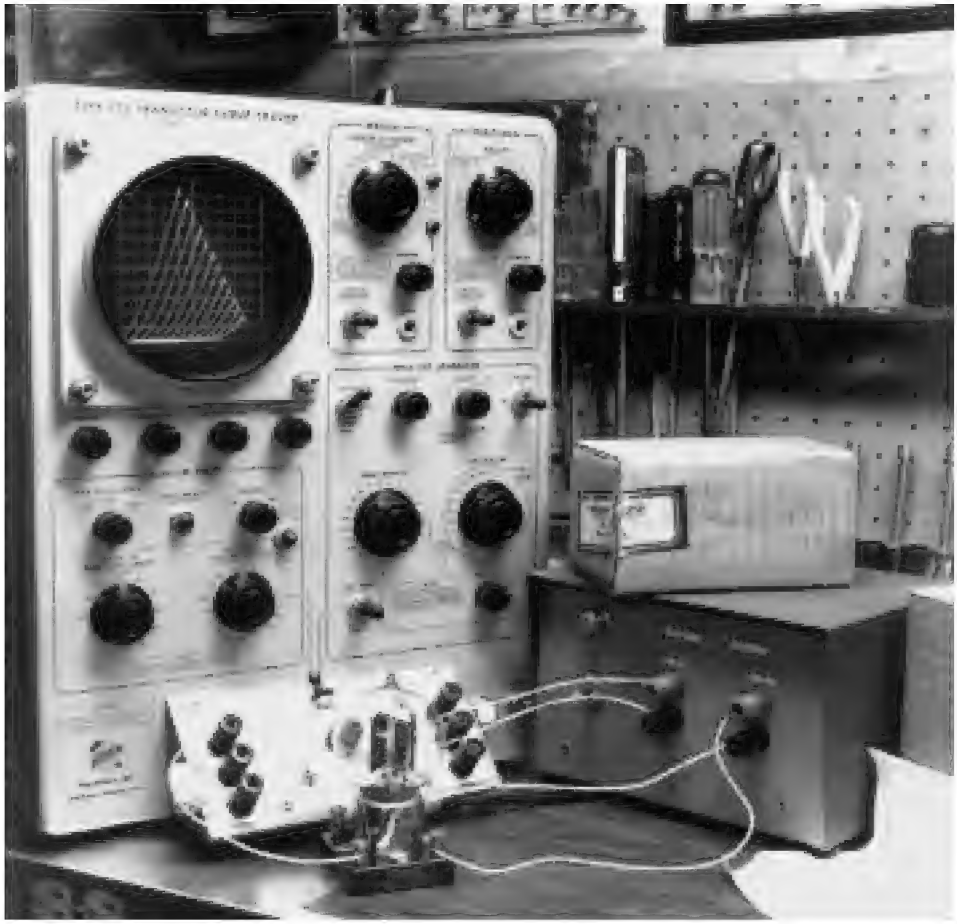
Tektronix made the model 575 and sold many more of them than 570s. Since the 575 is itself full of vacuum tubes—forty, with only two transistors—it is considered obsolete and is readily available on the surplus market. It closely resembles a 570. Availability, price, similarity:all of these suggest that the 575 deserves a closer look. More bad news/good news: the common 575 is quite unsuited to tube curve-tracing after all. But...it can be adapted.

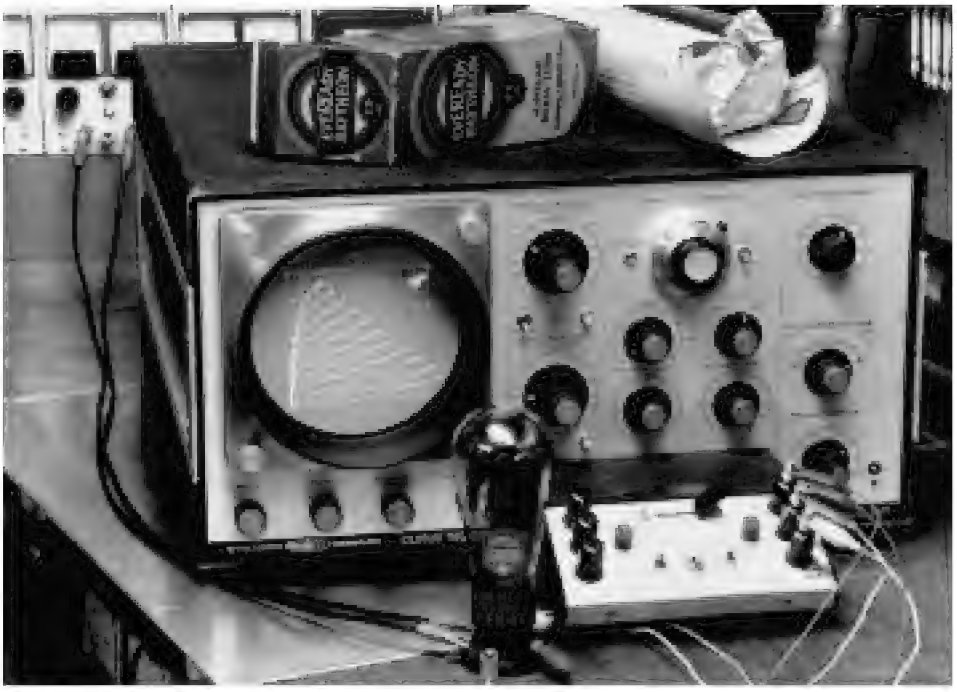
A stock 575 has two major faults: collector (plate) voltage and base (grid) drive. Plate supply is limited to 200 volts, about half of which is lost in the load resistor. Tektronix offered the "122C" modification to rewire the plate supply transformer to a bridge rectifier and obtain 400 volts. A completely new switch assembly was supplied, along with several trimmer capacitors to compensate for stray capacitance in the plate transformer. The horizontal volts per division switch got three additional ranges, up to 200 V/div or 2kV total (originally 200 V total; not much point going to 400 V plate supply if you can't see it on the CRT). A low-current 1500 VAC supply was added for checking peak reverse ratings of diodes, and even a new front panel came with the kit. While these changes could be made piecemeal without the official kit, it would be quite a project.Already-modified 575s are not rare, and command little premium over the stock instrument; they can be identified by the stamp "MOD 122C" next to the model number.

As originally configured, the 575 puts out current steps, as many as 17, of up to 200 mA each. To produce voltage steps, it feeds the current steps into a one-ohm resistor to ground, so it will provide 200 mV steps, or 3.4 volts total. This is not nearly enough to bias most tubes to cutoff. FETs were unknown in the mid-1950s when it was designed, so there was no requirement for more voltage. It is possible to use an external resistor of 10 or 100 ohms and get more voltage from the same current steps, but the internal supply voltage is only 15 V, so the amplifier runs out of headroom at about 10 V. Ten steps of 1 volt each are quite possible, though.

Evidently what is wanted is an external amplifier to increase this waveform to 10-volt steps and 100 V total, enough to bias a tube over its entire range. Such an amplifier has been described in a Linear Technology application note* and is not difficult to build, given a well-stocked junk box. I even used my 575—for its original purpose!—to select matched pairs of the high-voltage transistors needed.

The 400 volt plate supply of a modified instrument, although closer to 500 V at today's higher line voltages, is still none too much. Since you need a load resistor in the plate circuit (these are built into the 575 and selectable by a rotary switch), about half of the plate supply voltage is lost in the resistor.





Looking at the family of curves, the load resistance appears as a diagonal line on the CRT, extending from 400 V on the X axis to 400/R on the Y axis. This line is the upper boundary for any curves. The 570 was rated for 500 V, and probably gave more.

The 570 also had its own heater supply, and a variable regulated DC source for pentode screens, but these are easy enough to obtain externally. What is not so easy to duplicate is the switching for alternating between two tubes:

The 570 had them in parallel all the time, transferring the grid drive from one tube to the other while simultaneously connecting the "off" grid to -300 V.

The 575 switches both the base and collector, and has no source of -300 V available even if you wanted to do a massive rewiring. Also, if you build a transistorized step amplifier for grid drive, it will probably not appreciate having -300 V applied to its output even momentarily, but the Linear Technology application note does describe a version using a 12BH7 output device which can easily withstand such treatment.

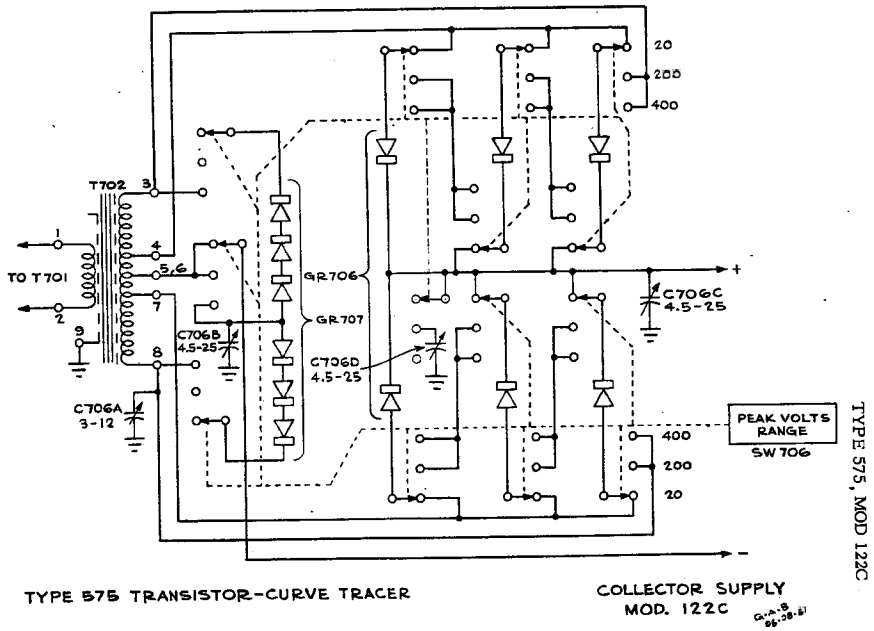
Neither will any of the transistor models provide both negative and positive steps simultaneously. A variable offset could be built into the step amplifier, however.

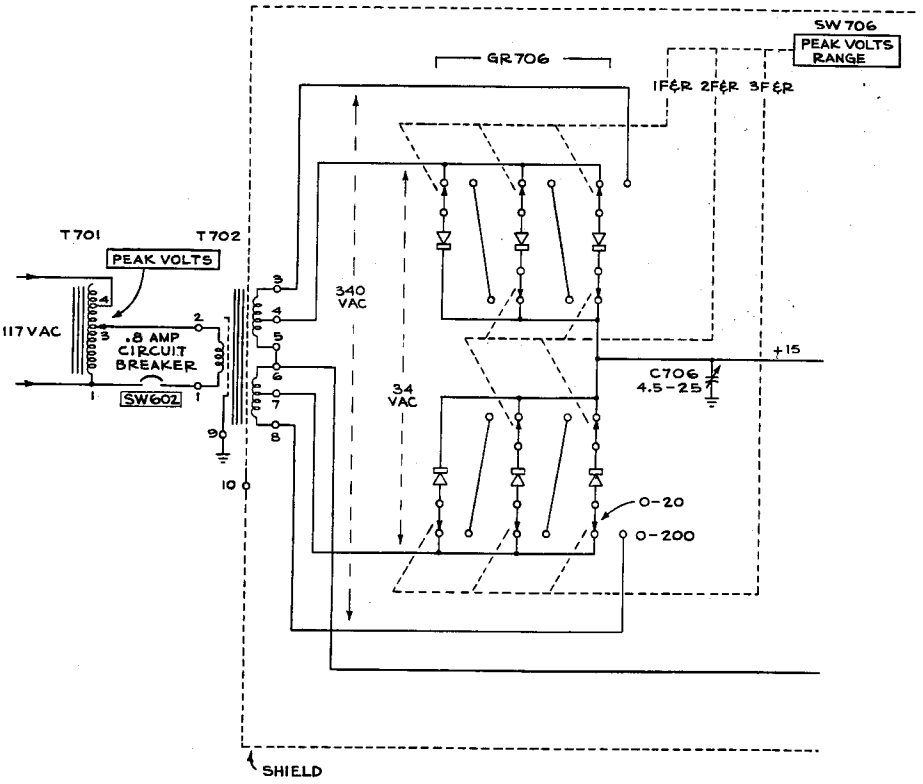
Tektronix 575s are generally reliable and long-lived. As with any Tektronix scope of its vintage, clean the switches, replace any black plastic molded paper capacitors with color stripes, and replace at least the final high-voltage filter capacitor if not all of them, before adjusting any calibration pots.

Tektronix had the curve-tracer market to itself for many years: the 575 lasted in the catalog from 1958 (or earlier) to 1971. But in 1967 Fairchild Instruments jumped in with a much-improved model 6200B, all transistorized, and capable of 35 volts of "grid" (base, gate) steps. Unfortunately Fairchild was poorly-run at that time, kept afloat by its semiconductor division profits, and its advertising budget and sales reps were no match for Tek's. Once Tektronix countered with a pricier but many-splendored model 576 in 1968,few people chose the Fairchild. Systron-Donner purchased the 6200B design and parts stock in 1969. The 6200B because of its orphan status sells for a lot less than a 576 but is capable of supplying 1000 V and will do a fine job on most tubes, with no modifications. The transistor socket/switching assembly looks awkward, protruding from the front panel, but can be unplugged.

If you're lucky enough to find an affordable one, a 576 should work well too.The later model 577 is not as good for power tubes because of the lower plate (collector) current range, and of course the present model 370 is out of sight for hobbyists. The 370 will drive an external plotter, but otherwise the only permanent record from any of these curve tracers is from a scope camera and Polaroid print, at a dollar a shot. A manually-operated plotter has some real advantages here;see S.P. #11, pp.26-27.

All of these curve tracers are intended mainly for plate-family characteristics, plate current plotted against plate voltage for fixed steps of grid bias, the usual curves given in tube manuals. Often the transfer characteristic is more useful in predicting linearity of a particular tube over a certain operating range: plate current plotted against grid voltage for a fixed plate voltage.** On the plate-family plot, linearity is indicated by equal spacing between successive lines, a difficult thing to see. While it is possible to get a crude approximation of a transfer curve on a commercial tracer, a simple homemade device is much better, such as





a single modern bridge rectifier could replace this entire business, though the front-panel markings would be wrong.

fig _

Tektronix 575 Mod 122C, with grid-step amplifier, running curves on a W.E. 205D.

fig _

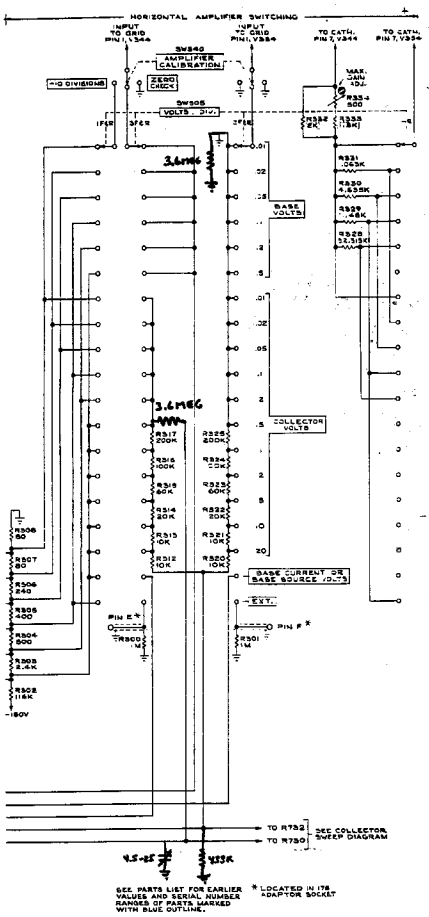
Systron-Donner (Fairchild) 6200B/P (programmable) running positive-grid curves on a triode-connected 46.

Alan Douglas

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the design published in Vacuum Tube Valley, issue no. _



*Application Note 18, available from Linear Technology Corp., 1630 McCarthy Blvd.,

Milpitas CA 95035-7487

**See S.P. #7,pp.24-25 for transfer curves of various 300Bs taken with a Tek 370.

And thanks for the original tip on the L.T. application note.

fig _

Partial schematic of the Tek 575 horizontal range switch. Adding two 3.6 megohm resistors will increase the volts/division ranges by ten. This is effectively what the Mod 122C did.

figs _

Partial schematics of the original and modified collector-sweep circuit in the Tek 575. The Mod 122C added an entirely new switch assembly, and two more rectifier stacks to turn this into a bridge. No doubt

SRPP POWER

The search for the best way
to get five watts out of a 6AS7

by Flemming Madsen

I am an electronic engineer and teacher here in Iceland. I began experimenting with audio about 30 years ago, beginning with Voigt pipes and transistor amps. For the last 13 years, I have been concentrating on tube amps, mosfets with tube drivers and direct drive electrostatic speakers.

The SRPP project in this article began as a sound check on a Class A2 driver for a Svetlana 811-10/572-10 amp intended to drive my 7´ high, 1.5´ wide full range electrostatics. I needed a driver with about 50 mA current capability and at least 50 V RMS. The easiest way to get this is using a pass tube like 6AS7 or its equivalent, the 6080.

I had good experiences using 6080 tubes in a PP amp for the electrostatics. The tube is very rugged. I have driven it for every day in 2 years now with max. dissipation but at higher voltages than recommended and no failures have come up so far.

To check out the sound of the driver, I built an amp with 6SL7 and 6AS7 in SRPP using output transformers from a scrapped Dynaco Stereo 35. This amp lived in my workshop for about a year. Everyone who heard that amp was surprised how good it sounded. It had powerful rich bass and clear engaging midrange. The amp was built using metal film resistors and both electrolytics and polyprops in the signal path—in other words, an amp built of crap.

I always tell my students that building tube amps will save the world, and I try the best I can to let them get the bacterium *highfideli-itis*.

One day I woke up to the fact that my student were making a horrible mess of some measurements on the lab table. It looked like a certain kind of Italian food. Then I could do nothing else but ask (in reality I roared) "what in h.... can we do to teach you work more systematically?"

They answered as a chorus:"What about building a tube amp?" I warned them, "But it will cost you money."I saw a lot of work planning it. "That's all right, we will pay," they answered. So, there was nothing I could do other than begin thinking about a project that was easy to build, good sounding, and cost next to nothing.

Soon I built a prototype around the SRPP 6AS7 amp in the workshop, putting a 6SN7 preamp in front of it with relay-controlled input switching. The original idea was to control the input switching with TTL logic, but in the end only one out of nine worked. The fact is that logic is crap—every tube freak knows that!

We ended up with a simple switch to control the relays, and it has the added benefit that the switch remains in the same position as you left it last time you used the amp.

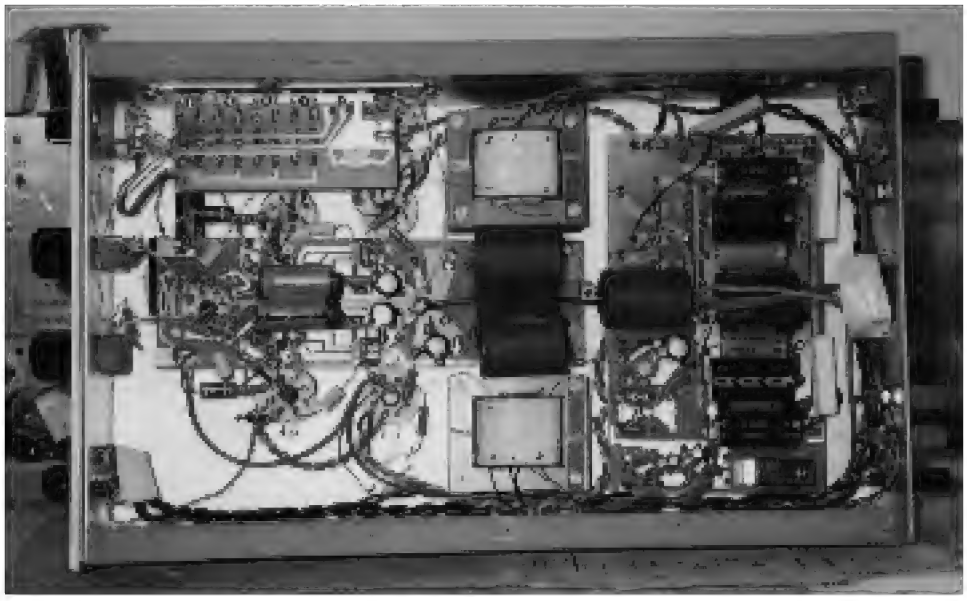
You can copy the amp as described below or use it as a platform for experiments. In the process of describing it, I will relate some of my experiences and insights about amp building to you.

But, remember I am not god—I only sound that way when I come forward with my opinions. You must be a critical reader, make your own decisions, and listen critically to your results before you'll get an amp that matches your equipment. That costs a lot of sweat and tears, but in the end you will have learned a lot.

Don't expect to be satisfied—if so, you would be the first that had been cured of perfectionism. Here you have a chance to get into tube amp building at low cost. Our amp cost about $430. All the items were gotten from four different companies. Most of the parts from Circlewood London. A little from ELFA Sweden. The tubes from Billington. The transformer iron and forms were provided by the local transformer maker. I will make a list on the Internet together with the PCBs and other drawings of the amp.

The platform described here is easy to change to other kinds of output stages with around maximum 15W power capability. The power supply is good and easy to match tubes from 2A3, 300B, EL519 and 6C33B, providing enough current for them all. Of course, you have to change output transformers to match the output tubes. You also must have separate windings for the filaments if using directly heated triodes.





If this is your first project, then it is best to follow the description. You can always upgrade later and would be much better prepared for it.

Input Stages

The input switch is built on a PCB with integrated phono plugs and DPDT relays controlled with 5V from the heater supply. The diodes over the coils are there to kill clicking noise. The way the input plugs and relays are mounted on the board, the signal path is as short as possible. The advantage with relay switching is that you don´t have the usual long cabling to a switch of often questionable quality. Good switches don´t come cheap. The relays are cheap and hermetically sealed.

Templates of the PCBs used as well as some wiring diagrams are available on www.soundpractices.com/srpp.html in PDF format.

There are two volume controls, one for each channel. It is difficult to get stereo volume pots that actually match. I think that we DIYers end up buying the crap that factories do not want, and pay 10 times more for it! Two volume pots is simpler and better and costs less than a stereo volume pot and a balance pot. I like the two volume control system best. You can get used to using two controls very fast.

The volume control is made as a voltage divider with a fixed resistor in series with the potentiometer. It sounds better that way. The signal goes through a good resistor (carbon composition or Allen Bradleys). The cost is a loss of gain but often this is not a problem.

I think that components shunting signal have lesser impact on the sound than components that the signal goes through. Logically, it is strange, because the current goes through both the shunt and the series items. As we know, a lot in the hifi scene remains unexplained, therefore if you feel it is better, let it be. At least you will feel better about it.

Have your own philosophy, be thoughtful about it, and don´t let anyone mix into it.

A good example about philosophy is how it is possible to build good gramophones with light and stiff materials with a little damping. Alternatively, build it heavy with materials with a lot of damping. Both kinds can be good sounding. But don´t try to mix the philosophies! If you damp the light built one the sound dies. Lightening the heavy one makes it resonate.

Before you modify hifi equipment, you must figure out the philosophy behind the construction. You can try make the light phone stiffer or improve damping of the heavy one. If you try the opposite, the sound will change radically and in most cases for the worse. If you hear big differences, then there is something wrong. OK... I think it is time to come back to the amp project.

The preamp tube is one-half 12SN7 for each channel. It is a plain plate-coupled connection without a bypass cap on the cathode resistor. It is possible to change the sound a bit by changing the plate resistor. For more body, try 12k and for lighter and more liquid sound, use 27kΩ. Anything between is also usable and largely a question of taste and speakers.

You can also try bypassing the cathode resistor with 220µF/10V HQ electrolytic, it will give more punch and a more massive sound.

I used the 12SN7 because of my experience of the amp in my workshop with a 6SN7 SRPP preamp. The tube sounds thinner plate coupled than in SRPP. It is alright if your speakers are not too bright. Perhaps it is better to use 6SN7 and step the heater voltage down from 12V with a 10Ω/10W resistor.

Then you have the choice of a lot of different brands of tubes and they differ a lot in sound. I like the ones with the triangular plates best, the 6SN7WGTA from RCA, for example.

With bright sounding speakers such as Lowthers, I would try the 5687 as preamp. It has a more full-bodied sound without losing the details. The plate resistor would be 7.5k–12k/5W and cathode resistor 330–390Ω/1W. The step down resistor from power supply changed to 6.8kΩ/5W. I have not tried it, but I think it would be a better preamp in this kind of system. Be aware of the different pin connections when you use this tube.

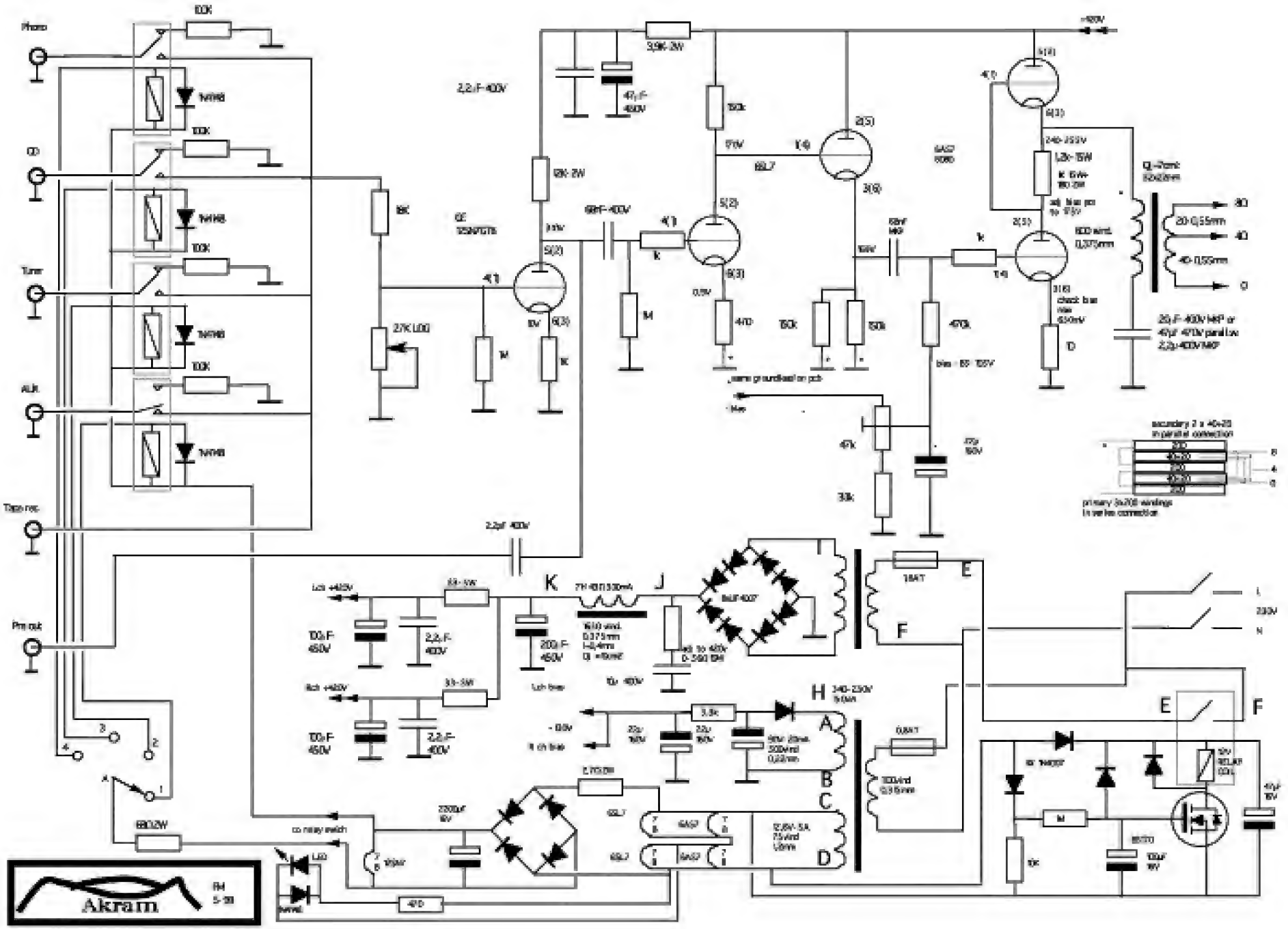
Don't try 12AU7—OK, it is full bodied, but dull and lacking details and a very sloppy bass. I think that a lot of that talk about tube sound with sloppy bass and rounded creamy sound is because of that tube. It was widely used for many years.

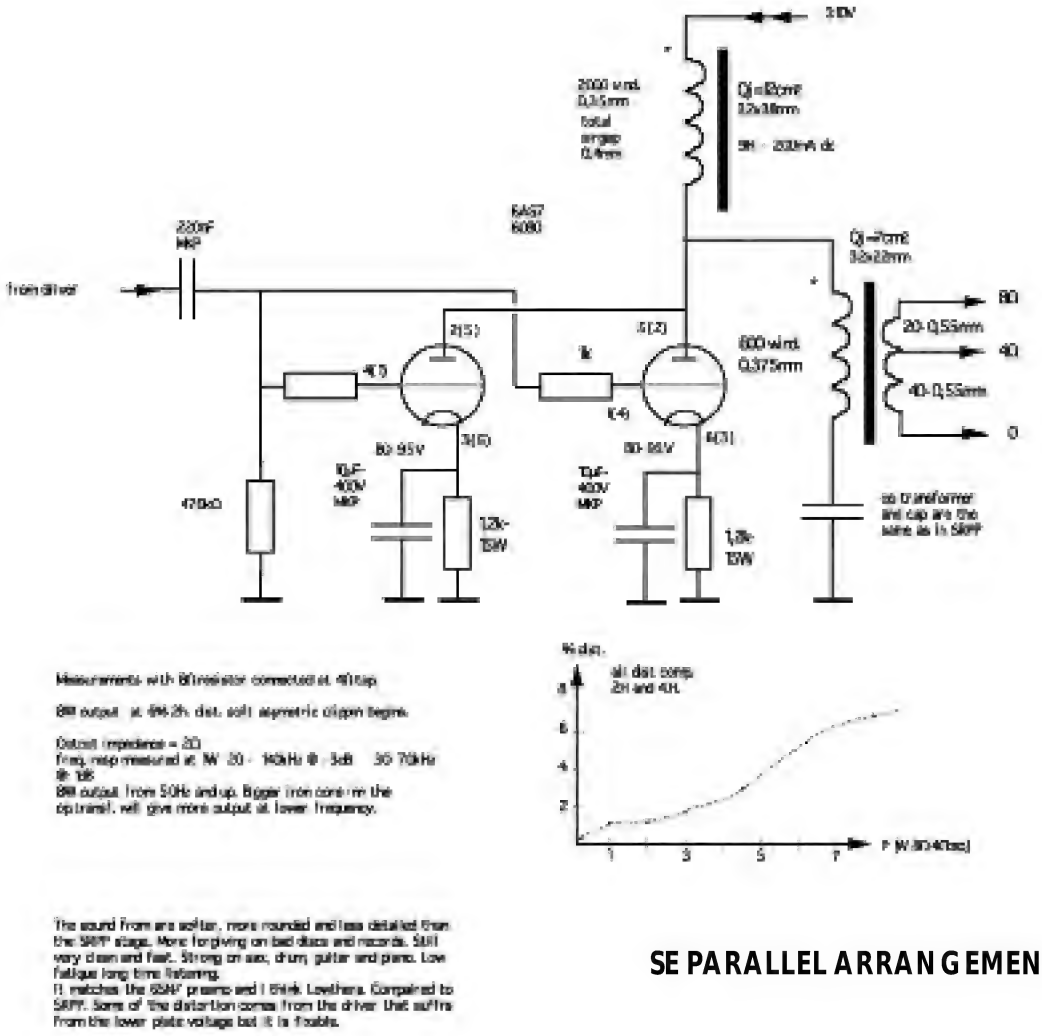
I have made a preamp output on the amp, but it is not capable of driving any length of cable. Connecting anything deteriorates the sound on the outputs. Actually, it would be better to use the jacks for an extra input.

Or use it as output from the output tube to drive a separate bigger power stage with, for example, 572-10s. I am thinking about trying this out. Perhaps a description on that later. With such a stage it would be possible to wake up normal 88dB cigarbox speakers, from the so called "high-end class." Wonder why it is called high-end? Were the constructors high when they made it? Or perhaps they tried to high-end their income by manufacturing these undynamic speakers with such high power requirements?

Driver Stage

It is my experience that voltage amplifiers make much more of a footprint on sound than current amplifiers. Therefore,


Akram
RH
S-28
Phono
CD
Tuner
AUX
Tape rec.
Pre out
100K
1N4148
2.2µF 400V
47µF 450V
3.9K 2W
150k
470
1M
27K LOG
6SL7
6AQ7
6080
6BQ7
6AS7
BA157
BA158
BA159
BA160
BA161
BA162
BA163
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SE PARALLEL ARRANGEMENT

the driver stage and preamp contribute at least 70% of the sound from a triode amp. It is from here by far that most of the voltage amplification comes from. The output tube has little voltage gain compared to the others in triode amplification. The primary stages are mostly responsible for the outcome of the amplifier.

To get enough drive to the power tube, the driver must have high voltage gain. The output tube requires about 70V RMS drive with little distortion. The 6SL7 is good for this. I love the 6SL7— it is fast, clean, and not too clinical.

First I tried SRPP driver with 1kΩ cathode resistors. It sounded fine, but the tube gods don't like putting identical couplings after each other. SRPP 6SL7 is a little rounded but not too much. Also, 6SN7 is fine (very clean) in SRPP but you will lose about 10 dB of voltage gain compared with the 6SL7. It would be worth trying 6SL7 preamp and 6SN7 driver, let me know if anybody tries it.

I also tried SRPP 12AX7 in my workshop. Actually, I have the choice with a switch, so that I could compare different hookups. It is fine but, as with 6SN7, there are big differences between brands. Some sound almost as dull as 12AU7 (bah) and some are fast and powerful (Sovtek WXGTA).

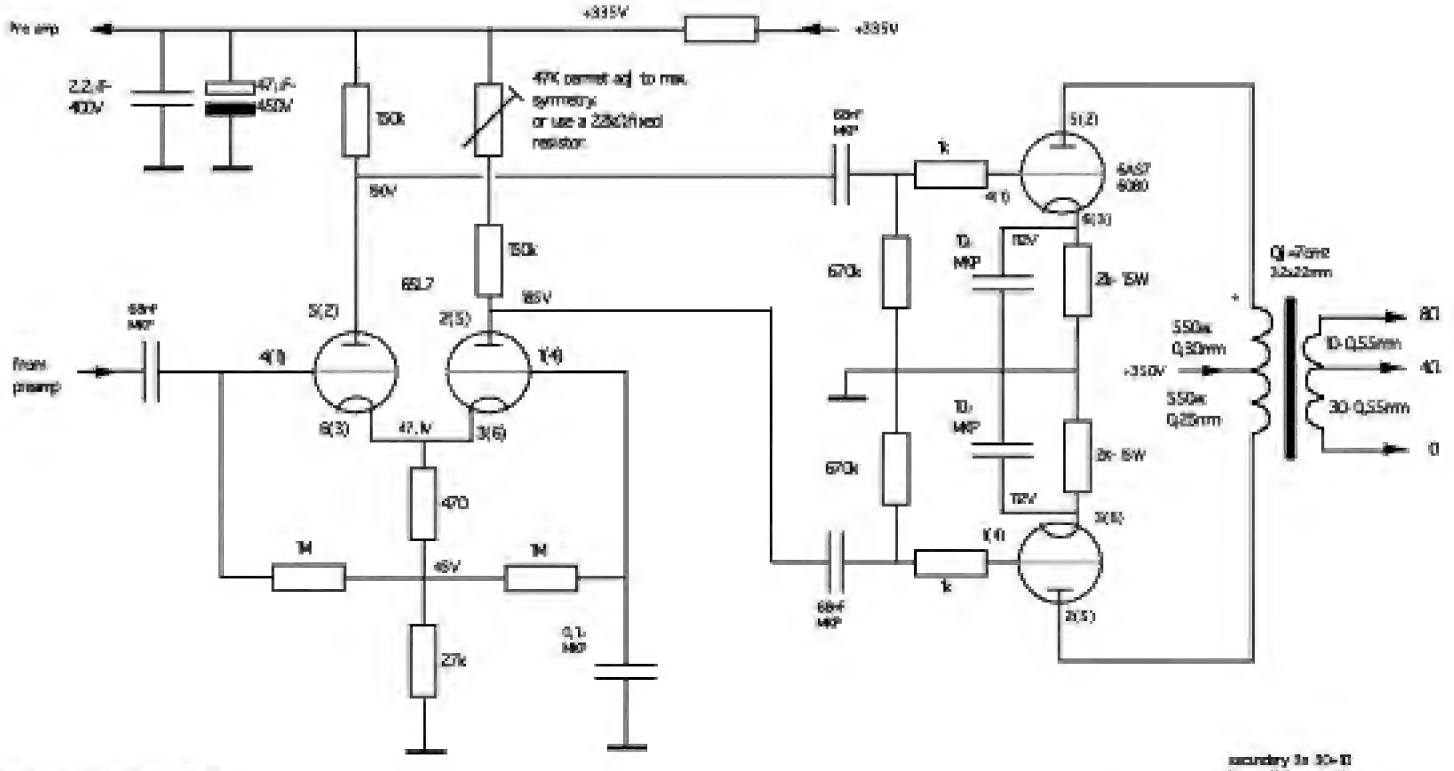
In the end, I chose a plate-coupled 6SL7 DC connected to a cathode follower to get good voltage drive and lower output impedance. I decided not to connect two SRPP stages after each other. The good priests say it is not wise and sometimes, like it or not, you have to listen to the tube gods. They say weaknesses will accumulate.

I am not sure this rule is entirely appropriate here because of the different tubes and very different working conditions. The output tube is heavily loaded by the speaker impedance and the driver is lightly loaded by the very high input impedance of the power tube paralled with a 470kΩ bias resistor. The sound is crisper with plate load/cathode follower. By trial and error, I selected the plate and cathode resistors and ended up with 150K and 75kΩ. That made the lowest distortion on the output and a fast, clean, and crisp sound that matched the 92dB Voigt pipe speakers most of my students have. On my Focals, I find it a bit cold, but the sound is not far from a 2A3 I made for a friend.

For coupling caps I ended up using Wima MKP10 polyprops. Later I tried Audio Note aluminum foil/paper in oil but I was surprised how little difference they made. To excuse my bad hearing, it was difficult for me to compare the cap because of the long break-in period of the paper and oils.

The coupling caps are small, 68nF pp and

PUSH-PULL ARRANGEMENT

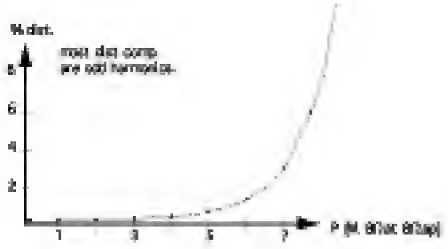


Measurements with 8Ω resistor connected at 8Ω tap.

SW output at 5% dist., soft symetric clippin begins.

Output impedance = 1,6 Ω
Freq. resp measured at 1W 10- 55kHz @ - 3dB 40- 28kHz @- 1dB
SW output from 50Hz and up. Bigger iron core inn the opt.ransf., will give more output at lower frequency.

The sound are a bit like the parallel. But very much normal and rather boring. Not crisp as SRPP and not forgiving and euphoric as SEP, not anything it just plays as it is said to do.
The amp is much more complicated to make than parralled , I dont think it is worth it. Take a look at the distortion curve, it is very saleable. One more time PP looks well on paper but the sound from it dont live upp to it. Specially if you have the other concepts to compare with.



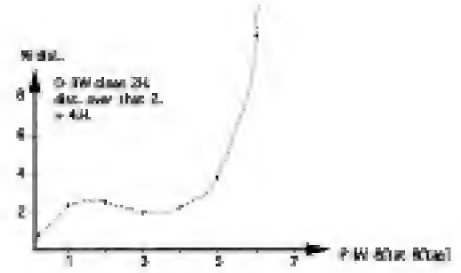
Measurements with 8Ω resistor connected at 8Ω tap

SW output at 5% dist. soft symetric clippin begins.

Output impedance = 2,1 Ω

Freq. resp measured at 1W 10- 55kHz @ - 3dB 22- 35kHz @- 1dB
SW output from 30Hz and up.

The sound are fast crisp very dynamic with tight bass.
Lot of ambience and room. The amp is sensitive to bad records and cds.
Strong points are snare drum, hi hats, claps, trumpet.
Sax and violins are a bit thin, I think that 5687 preamp will much better than 6SN7.
Strange distortion curve. High second harmonics but very constant over a big power range. Perhaps it's the secret of surprisingly good sound compared to the distortion rating. You dont get tired of listen to the amp.



47nF AN, compared with normal practice. This is because I wanted a small amount of filtering—together the coupling caps make a high pass filter of about 10Hz. There is no reason to force the power tube to pump too much subsonic audio from warped records into a transformer that will just eat the current without transferring it. The low frequencies, although not audible, will modulate higher frequencies in the power tube and the power supply will be heavy loaded, so you will get nothing instead.

In the beginning, I did not like this driver because of the two stage configuration. But, in reality, SRPP and my follower also are two stage amps. But you don´t see it as easily. The cathode follower is just put on top of the plate coupled stage. I never tried my follower in this amp. Long ago, I gave it up. It has never sounded right for me. It eats detail compared with SRPP.

In most cases, I like the SRPP best. The sound is clean and human and doesn't change a lot with the working point. In other words, when the tube gets old and tired you won´t hear it very much. The shunt regulated push pull is an easy and forgiving friend to work with. I prefer it in all amp stages from line level and up. While it works for me, I also know that other DIYers have had bad experiences with the SRPP.

Output Stage

The output stage is plain SRPP with the lower half DC biased. The 1kΩ resistor in the grid of the lower tube is to prevent the tube from oscillating. I am not sure if it has to be there. I have not had problems of that kind, perhaps because I always use a grid stopper resistor and always try to make all wiring as short as possible.

The bias voltage is fed to the tube through a 470kΩ resistor. The bias voltage differs a lot from tube to tube, also the halves can differ substantially. This is one of the biggest problems with the 6AS7 and other pass tubes.

In the school project, we had the opportunity to swap tubes so that everybody got tubes that were fairly close in bias voltage. It is preferable to have the bias voltage high to get the highest power from the tube. A tube with higher bias voltage tolerates higher drive voltage before it will eat the upper half of the drive signal with the grid to cathode diode. Higher bias also means more current swing with less input.

In my circuit, the upper half of the tube works as a current source that tries to help the lower tube to draw current. When the plate on the lower tube goes higher, the grid of the upper one also goes higher (less negative). Therefore the cathode follows the grid and the upper tube opens up more for the current through it.

The voltage gain of any SRPP is about the same as mu, in the case of 6AS7, a voltage gain of about two. That is very low, and to make bad worse, under load I have measured input and output voltages to be the same, a voltage gain of only one. Therefore, the 6AS7 as SRPP output tube is only a current amplifier—and therefore has much less impact on sound than you would think.

The 10Ω in the cathode of the lower half, has two different purposes. First, it makes current measurements easy. Voltage across the resistor divided by 10 is the idle current of the tube. Secondly, if the tube should short circuit or lose bias, the resistor will blow up and stop further destruction in the amp and power supply.

The output signal from the output tube is AC coupled through a cap to the step-down transformer. The cap is put in the ground connection of the transformer. I chose this connection because it's my experience that harsh (lifted highs—subjective not measured) sounding caps in series with signal sound dull when used as decoupling caps. In the amp here we have two harsh sounding polypropylenes in the signal path of the voltage amplifier stages. If my theory is right, it must be fine to use a harsh sounding pp in the decoupling of the output transformer, to balance the overall sound. At least I hear it that way. But perhaps it's because I think it is right. Psychology and hifi have a lot in common. No answer is absolutely right, and there are different theories about the same problems.

I have used 47µF electrolytic paralled with 2.2µF MKP. I also have tried 2 x10 µF paralled. I expected better top end and worse bottom. But again the break-in time of the change spoiled the direct comparison. I must admit I can't remember small sound differences for days or weeks. After that long of a time, I only can say whether I like the change or not. It becomes, as always, a matter of taste. Try it yourself and make your own responsible choice. Life is not meant to be easy.

Output transformer

The SRPP output stage has an measured output impedance of about 200Ω. Therefore, a matching impedance between 800-1kΩ would be about right. The primary-secondary ratio should therefore be √ (800/8) or 10 to 1. The old Dynaco transformers I began with had about that ratio, when the 8Ω tap was used as secondary and the primary was taken between the two screen grid taps. The amp worked fine with the Dynacos. The bottom was very powerful but the top-end lacked a bit of air. I think you can use many different push pull transformers in this amp, both old and new ones. However, I prefer to wind the transformers myself.

In the school project, we wound our own transformers. It is by far the cheapest route and easier than many think. I also think that it is good to learn how.

There is a lot of fuss about the difficulties of transformer winding. Very true, it is difficult to wind an Ongaku transformer with 16kΩ primary impedance at 20 Hz (127H and pr/sec= 45/1), a lot of DC current through it, and to insulate for 3000V DC on the primary. Oh yes, that costs a lot of work and skill. I think it would be cheaper to buy that kind of transformer, compared to the work required winding it.

But, come on, we can wind a transformer with no DC current through it, a 10:1 ratio, and a primary inductance about 10H. That will give you 800Ω at 12 Hz. Our homemade transformers perform well. They measure <10Hz– 120kHz within -2dB. We used M6 iron from the local transformer supplier. The core was 32 x 22mm (Qj = 7cm2). The windings were interleaved 5 times. In other words, 3 primary windings series connected and between them 2 secondary windings paralled. See the specs and wire dimensions in the schematic.

Our transformers perform better than the Dynacos in the treble but not in the bottom end. When measuring the amp, 20 Hz sine waves have distortion when the output voltage exceeds 3 V into 8Ω. More iron will cure that problem.

Next spring, when my students build an amp, I will double the iron core. The bigger core will store more energy for the bottom end. The E and I laminations are put into the coil 5 and 5 together, making a little air gap in the core and linearizing it. The sound will be lighter and less

mechanical, and the break-in period much reduced.

I always use non-magnetic brass screws and insulate both sides of the transformer with fiberglass PCB. It is best not to use pots and frames made of scrap iron from old cars. At least, if you use this crap put thick cardboard or PCB spacers between them and the iron core. Don't forget to isolate the brass screws. Any connection between the sides produces loss in the transformer, and it is the last thing you want in an audio transformer. If you don't do what I suggest, you will end up with an amp that looks nice but sounds mechanical and compressed. Fellows, the choice is yours.

Perhaps later I will write an article on transformer winding, derived from an old Danish book I found. It is easy and the transformers work well using the modern materials of today.

Transformers are far from perfect on the test bench, but it is surprising how little impact they have on the sound. Caps measure near-perfect compared to transformers, but have a lot more impact on the sound than anyone should expect. Nature is strange.

Power Supply

The power supply is very plain. No tube rectifier is used in order to hold the costs down. It is much simpler to use a bridge rectifier. Only one winding is required for this, you must use additional windings for tube rectifier. In our project we recycled transformers that we had been given from an aluminum plant nearby. Therefore, we have two power transformers one for plate supply and one for heater and bias.

The high voltage rectifier is built around 8 UF4007 diodes, an ultra-fast equivalent of 1N4007 1000V/1A diodes. I series connected them two in each branch so that they can withstand 2 kV in reverse. Really, it is not necessary, but I like it better because if one gives up, the other can do the work alone.

I remember waking up in the middle of the night when a diode in my old Dynaco power amp had given up, the power transformer overheated, and all the black stuff in it had began to boil. It stinks, I tell you—I get bad feelings thinking about it today, 15 years later!

The output voltage from the transformer is 340V@600mA, more than enough. But remember at the place where overkill is a must, a bigger power transformer is always better. After rectification, the voltage is decoupled with a 10µF MKP/400V cap, in series with it is a 10W resistor between 0 and 56Ω. It allows adjustment of the output voltage from the supply by changing the resistor. With no cap, the supply gives out about 300V and with 10µF it gives about 450V when the amp is loading the supply.



After the adjusting cap is a 7H choke @300mA. The airgap in the choke is adjusted with 2 sheets of ordinary writing paper(80g-m2 paper is 0,1 mm = 4 mil), it will make an airgap that is 0,2 mm. The paper is placed between the E and I laminations. All the E blades are together at the same side, then the two sheets of paper cut in size, and then all the I iron together on top.

It is easier to screw the choke together if you apply about 10 V dc to the coil. Then the magnetic field in the iron core will hold the choke together while you are working on it.

After the choke are filter cap banks made of two 100µF@450V caps paralled. After that, the left and right channels are isolated with 33Ω/5W resistors and then decoupled once more with 100µF paralled with 2.2µF MKP, one for each channel. The preamp is further decoupled by 47µF paralled with 2.2µF after the 3.9KΩ voltage dropping resistor feeding the preamp tube.

The bias supply is rectified with only one diode UF4007. One is enough because the bias draws next to nothing in current. But it is preferable to decouple it well to get rid of garbage and noise from the AC power lines and switching noise from the rectifier diodes. Any noise on the bias voltage line will be injected directly into the drive signal of the output tube.

The heater supply is also very plain. Output tube and driver are heated with AC. Left and right channels are series connected to the 12.6V output of the transformer. The preamp tube is heated with 12VDC after rectification. I hard wired the bridge rectifier and cap directly on the preamp tube to get as little switching noise as possible. The lead length between the rectifier and the cap is nearly zero. The output voltage is adjusted by the 2.7Ω/2W resistor and it also compresses switching noise by lowering loading currents to the 2200µF cap—it takes a longer time to load the cap, therefore the rise time of the noise goes down, and it is easier to get rid of by decoupling.

The control voltage to the input switch is taken from the heater supply and stepped down to match the 5V relays. It may be necessary to adjust the resistor if you use different relays than I did.

The power supply is mounted on a PCB. I like best to use it upside down. The advantage is that you don't have to loosen the PCB every time changes are made. The only thing to be careful of is that it is strongly advisable to mount the caps at least 2 mm over the copper foils. The insulation is not made to withstand 450V constantly for years with a lot of heat.

You can get the PCB design on the net. I have used this power supply PCB for years in all kinds of tube amps as a universal assembly like the input switch PCB.

On one side of the PCB there is a little timer connected to a relay that switches on the plate transformer 1-2 minutes after the heater and bias. This is done to protect the caps in the power supply from more than 450V in the start up period. The power tubes also will last longer, the cathodes will not miss electrons in the start up when they are too cold to emit enough electrons to provide high currents. This is also called cathode stripping.

Don't forget to phase the power transformers correctly. Measure the AC voltage between earth and the chassis. When you get the lowest voltage you have found the right connection to the power line, so mark the cords with live and common. If you have not done this already, you must do it with all your equipment one at a time, they must not be connected together, and the ground lead must be disconnected while you do the measurements. By doing this you minimize the ground currents between all your equipment. Soundstage improves and the sound gets cleaner.

Practical things

The amp is built on an anodized aluminum plate. The template will be on the net in PDF 1:1.

The power transformers and choke are placed on top of the chassis together with the tubes. The output transformers are under the chassis. The sides are made of 16 mm MDF form and the front plate of 4 mm aluplate. The text on the front is made with dry transfer symbols.

All the ground connections are star-grounded. To make life easier, I made a PCB to mount between the tubes with all the ground connections and space for bias components. It too is available on the net.

Use a loose power cord and a connector so that you have the opportunity to switch power cords. Make them yourselves. Thick braided wires work well. You can get inspiration in *The Cable Cookbook* from Allen Wright. It is a must-have book.

Use good wiring between the input switch, volume pots and preamp tube. It is best to use twisted wires. Or better yet, silver foils from Allen Wright. I don't like shielded cables—they eat the soundstage. Make the connections as identical as possible for left and right channels. That also enhances soundstage. I have placed the input switching board in the front of the amp to make signal paths as short as they can be.

After finishing the amp, apply power in steps. Begin by checking the power supply without any tubes in the amp. Adjust the bias voltages to –90V, check the heater voltages and high tension. Put in the tubes and adjust the plate voltage on the lower power tube to 180V. Check the voltage across the 10Ω cathode resistor—it must never exceed 0.7V. If it does, you may have to lower the supply voltage by adjusting the resistor in series with the 10µF power supply cap. Readjust the amp after an hour when everything has gotten hot.

Let the amp play music, or better yet, use an XLO burn-in disk for at least two days and finish up with the demagnetizing tracks on the disk.

Use two 10Ω/10W resistors as a dummy load for the break-in period, to protect cat and neighbors while you are at work. You can listen to the amp after a short time but the full break-in period is much longer, so be prepared for changes for the next month at least. Let the amp play as much as possible. It is not enough to just have it on, it must play signal to become softer with time.

Also fix the absolute phase before you listen critically, again using the XLO disk. This disk is one of the best things the high-end guys have come up with. I can't live without it.

I have not investigated silver foil wires for the loudspeakers but I use copper foil 5mm wide made of foil from the local transformer supplier. He uses the foil for electrostatic screens between primary and secondary windings in power transformers. Strip down the foil and insulate it with a good tape and you have a good and cheap speaker cable.

Somebody might ask, "Why SRPP instead of a cathode follower?" I thought the same way and even tried it, but got only about 2 watts from it and much worse overall performance. I dropped it without thinking about why it performed so badly. I think I must have done something wrong, but I don't care.

The distortion of the SRPP amp is clean 2nd harmonic to about 3V output and then the amp gives more and more 3rd harmonic until clipping begins at about 6V into 8Ω.

Some tubes gives 5.5V before clipping and others about 6.5V. I have a pair of RCAs that give 7V. The performance is about the same as 2A3s are capable of. The sound doesn't differ much from a 2A3 SE amp ("Baby Ongaku" with home-wound transformers) I compared it with.

Close at last

To complete this article, I will give you alternative connections of the 6AS7 power stage with the component values and a brief subjective description of the sound and the measured performance.

The differences in sound are not very big but the power performances and measurements differ a lot. I tried to let some of my fellow patients with a high degree of *highfideli-itis* make comparisons in an AB listener test of three different amps: SRPP, push pull Class A, and paralled SE parafeed. On nine different records every amp was named best amp three times!

But there were problems with the preamp. I used one of the 12SN7s as preamp into all the amp inputs at the same time. We knew that the preamp wasent that great and, what's more, it did not have capability to drive all the tested amps at the same time.

So, I will not put to much authority in this formal "test." Instead I will give a brief subjective description of how I find the long term sound from the different coupled outputstages, together with the data and distortion curves.

Another thing is that AB tests seem to magnify small differences compared to long-term listening. Perhaps records, gramophone, amplifier, speakers and the soul of the listener must be burned-in together before anybody can make critiques of anything.

OK, we are back again to a combination of psychology, perfectionism and engineering, blended with religion and an expensive world-wide disease nobody can, or even tries, to cure, called *highfideli-itis*.

So, make your own choices and don't expect to be fully satisfied with the sound of your equipment. If that happens, then you are getting old... start making yourself a coffin out of your VOT speakers!

Not Your Father's Dyna Mod…



Retrofitting the
Push-pull Pentode Classic
for Single-Ended Triodes

by Ross Lahlum

Psst... wanna buy the world's heaviest ST-70?

This project began as a quick experiment to find out what all the commotion was regarding DHT SE triode power amplifiers. I had a Dynaco Stereo 70 chassis with good iron,which I had planned on using sooner or later with an Audio Research upgrade from an old Glass Audio article ca. 1978. I never finished it, however, putting the whole project aside for several years. Last year I stumbled across some UTC HC-116 parallel feed chokes (150H at 16 mA) and bought them & put them on the shelf. At the time, I didn't really see a use for a choke at such low current.

Then somebody on the JoeNet (Grover Gardner) suggested the 46 as a nice driver for a P-P 2A3 amp I was building. People also started talking about the 46 as a lower-cost alternative to the 45 in amps in the 1 - 2 -watt class. The 45 is known for its musicality & sweetness, and the 46 is more or less a 45 with a screen grid added.

The 46 was designed by RCA as a dual-purpose tube. A pair configured as high mu triodes (both grids tied together) in push-pull Class B could deliver up to 20 Watts, while the same tube, with grid #2 tied to the plate, could serve as a Class A triode driver for the push-pull pair. Experimenters in the late '90's found that by connecting the screen to the plate, one could get a triode even sweeter sounding than the 45. Plus, they work well even at low plate currents of 20 mA or less. Check out the plate curves. These tubes are pretty linear even at low plate currents.

So I bought several 46's & got to work on a parallel-feed 46 amp using Dynaco iron. Please note that this is NOT a Stereo 70 mod (I had to tell Joe that so he'd agree to publish the article). I used Stereo 70 iron because that's what I had. You could pull this off with a wide variety of PP OPT iron, including all manner of Fisher, Eico, Knight, etc. amps. You're best off with OPTs that have a primary impedance between 4K & 8K. The 46 has a plate resistance of 1700 ohms, so a good rule of thumb is 2–3X that. Lower Z will get you more power, but also more distortion. If you go higher, you'll lose some power but distortion will improve.

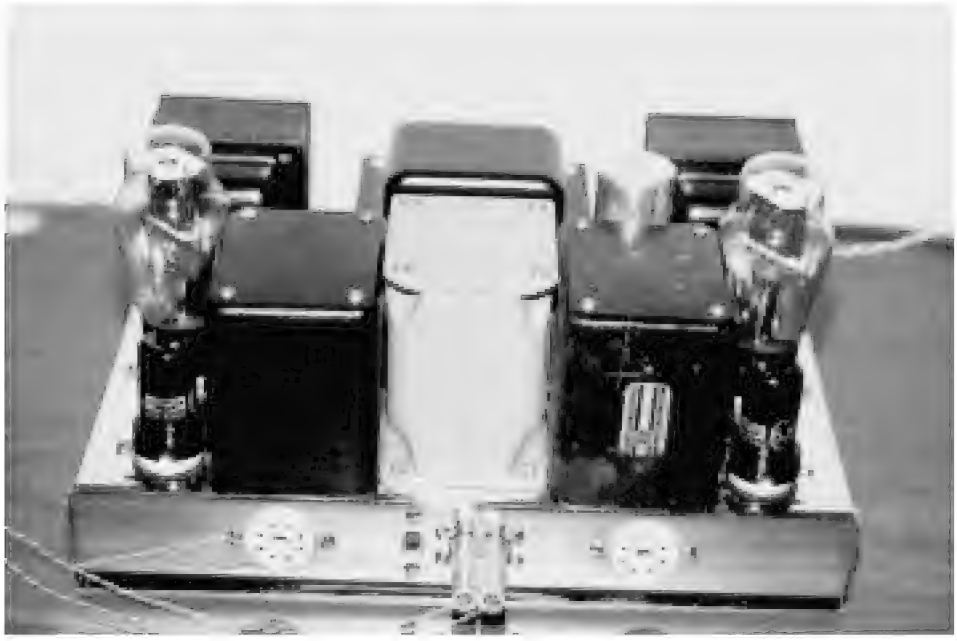
The Stereo 70 OPT is 4300 ohms, center-tapped. By using the full primary (just put some heatshrink over the c.t. so it doesn't touch anything!), you're at about 2.5X the plate resistance - just about right! I wasn't too concerned with power because this amp will be used with horn tweeters once I get the horn system put together; but with parallel feed the –3 dB point is about 15Hz on the low end,so it sounds great with efficient full-range speakers.

Mind you,if you're going to use this amp for tweeters only, you don't even need to pop for parallel-feed chokes. Just run the plate current right through the OPT iron. God forbid, you say, you're not supposed to do that! Well,you're not,because the core will saturate at low frequencies. But keep it low enough, and the amp will work, even though the low frequency cutoff point will be raised. That's what I did at first, just hooked the thing up to the OPT & ran DC through it, because I was impatient…and that's when I heard the DHT SE sound for the first time.

Whoa! Never heard that kind of sound before... Yeah, the bass was thin, and I couldn't crank the volume, but there was something really special there. So then I hooked up the DC feed chokes & the bass came in like gangbusters. But hey, if it's a tweeter amp, who cares? Save your money, build two sets of amps, and biamp!

I ran the amp for a while at 20 mA standing current and found that I was only getting about 600 mW of power, so one day I decided to push my luck with the UTC chokes. Although they are rated at 16 mA for 150 Henries, I reasoned that, due to the low plate resistance of the 46, I could afford to pay the penalty of lower inductance for higher current.

Judging by the DC resistance , I figured i'd still be safe running them at 30 mA. So I went ahead and kicked the output current up to 30 mA for a higher operating point. Now the Po went to over 1 Watt, I got to a more linear part of the curve, and a higher operating point, and as a result the amp got more punch, detail and sweetness (i.e. less grunge on peaks).



Of course, if you buy your own plate loading chokes you will have the freedom to choose your standing current. Based on my results, I would recommend running the tubes at 30 mA. I did try even higher current, up to as much as 40 mA, but did not notice any improvement past the 30 mA point. You don't really need 150 henries, you can get by just fine with 50 or 60 H. Magnequest has a nice line of plate loading chokes that I plan to try on my next amp, using a larger output tube like a 2A3 or a 300B.

I'll digress for a minute & talk about how I'm setting up my crossover for the biamp horn setup. My line stage has a transformer-coupled output. It's got a 26 DHT similar to Tom Ronan's line stage but instead of an RC-coupled output I used a Triad HS-54, which has a 20K primary & a 600 ohm secondary. No DC is allowed on the primary, so I used a constant-current FET to supply the plate with about 5 mA and cap-coupled the OPT. Again the 2 to 3X tube plate resistance rule-of-thumb applies. The data sheet shows that with 135 volts on the plate and a standing current of 5.5 mA, the 26 has a plate resistance of 7600 ohms. 20k is 2.63 times that, so we're in a pretty good region for distortion vs. power.

Since my line stage has a 600 ohm output, I got some Daven 600 ohm variable attenuators & went to town. If you look around at UTC iron, you'll soon learn that the price can be sky-high for some of the more popular items like LS-series & A-series input & output iron. But there are a lot of oddball parts floating around, too, that are of excellent quality, but since the applications are obscure, the price is correspondingly low. A ham friend actually gave me an LS-30 mixing transformer, and, as luck would have it, I soon stumbled across several more.

Since the LS-series are built like a brick outhouse, I thought they'd make good interstage trannies, but,because they have windings of 600 & 200 ohms, the primary is just too low for a plate load, so they sat on the shelf for a while, until I started thinking about a crossover. What's cool about mixing transformers is that they have multiple secondaries. You can take the output of your linestage, split it in two, and build a crossover using one winding for the highs and one winding for the lows.

Follow each side of the crossover with a 600 ohm variable attenuator, and you're home free with a passive adjustable crossover that sounds great! Since it's 600 ohms it's easy to design the crossover modules and you can build a variety of crossover modules to play around with & get the frequencies you want.

Voltage Amplifier Stage

The first stage of the amp uses a 6J5,a wonderfully linear and musical medium-mu triode, especially if you treat it right.This tube has a very straight and evenly-spaced set of plate curves at around 8 mA and 160 volts, so I decided to use a constant current source to keep it right there. The constant current source serving as the 6J5 plate load is a shameless copy of John "Buddha" Camille's Constant Current Source (CCCS) as described by the boys at Electronic Tonalities. I tweaked it just a little to get the voltage & current I wanted on the 6J5, and to use transistors I had on hand.

You can use this or some other CCS, or if you want to keep it simple, just use a plate load resistor, setting the value to get the right voltage on the grid of the 46. The CCS does do a nice job of keeping the voltage amp linear, and you get the full mu of the tube since the plate load is effectively over 1 megohm. To picture what a constant current source does, look at the 6J5 plate curves. Instead of drawing a load line the way you normally would,intersecting B+ on the X-axis and plate current on the Y-axis, just draw a horizontal line at your plate current. (see sidebar)

You can see how this keeps you in a very linear region. Tube purists may balk at this, but believe me, there is no mechanical solid-state sound in this stage! It is just very sweet and crystal clear. When you stop & think of it, little or none of your signal will be touched by those transistors, because the impedance is so high. An added benefit is the excellent isolation provided from the power supply; the voltage amp is very well decoupled from the next stage and its neighboring channel.

I figured a good place to build the current sources would be on the two octal tube sockets Dyna so thoughtfully placed on the front of the Stereo 70. One LED is centered in the keyhole, which has a nice visual effect when the amp is on. You can use whatever you want, but I had some extra ceramic octal sockets, and chose them for purely aesthetic reasons. (When you make your own stuff, you can do whatever you want!)

You'll need to heatsink the MJE350. I fabricated a clip from a terminal lug, and used one of the tube socket screws to anchor it. Be sure to electrically isolate the MJE350 from the chassis - that heat spreader is also the transistor's collector.

I used another trick that's been bounced around on the JoeNet to finish off the voltage amp stage. I wanted to avoid a big cap in the cathode, but I needed the full gain of the 6J5, so I put a 3.6 volt NiCd battery in the cathode circuit. This puts the tube in self-bias, with the cathode at a very stable point, and maintains a very low impedance to ground at the same time.

The NiCd battery pack I used was a 3-button-cell cordless phone battery pack I picked up at the local Batteries Plus store. I've since seen these in some of the surplus catalogs for less money than I paid. The

How to calculate L & C for parafeed

It's not hard to figure out what values to use for the plate loading choke and the DC blocking cap for a parallel feed arrangement. You already know the value of L.

I'll use 150 H for this example, but if you're building from scratch,you'll probably use a choke with a lower inductance, say 50 or 60 H.

To find the value of C, simply plug & chug with the old standby equation

$$Fc = 1/(2 \pi \sqrt{LC})$$

If we use a 2 uF cap in series with our 150 H inductor, we get a -3 dB cutoff frequency fc = 9.19 Hz.

That ought to be low enough! Now suppose you're doing this with a 50H parafeed choke. You'll get an fc of 15.92 Hz with a 2 uF cap, still OK.

Now the above is actually a bit oversimplified, because it does not account for the inductance of the output transformer, which in effect is in parallel with the DC feed choke. Push-pull OPTs generally have fairly high primary inductance, so this does not present a big problem.

For example, let's say my OPT has an Lp of 80 H. I haven't measured it,but that's a typical number for this type of OPT. Then we just plug the parallel value of the two inductances, or 52.2 Henries into the equation, with a resulting fc of 15.6 Hz. (I actually measured a -3 dB point of 18 Hz on this amp, but I know I lost some inductance in the DC feed choke when I cranked the current above the rated 16 mA.)

Calculating R values for the CCCS

In the CCCS, R4 sets the current output, while R3 is sized to accommodate the B+ the current source has to start out. The value of R4 is given by Electronic Tonalities as

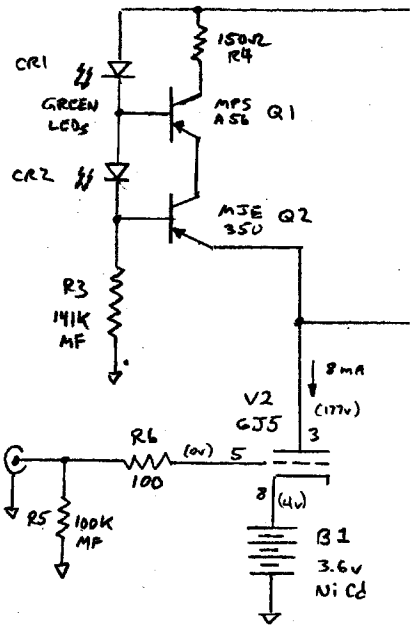
R4 = 0.95/Ip

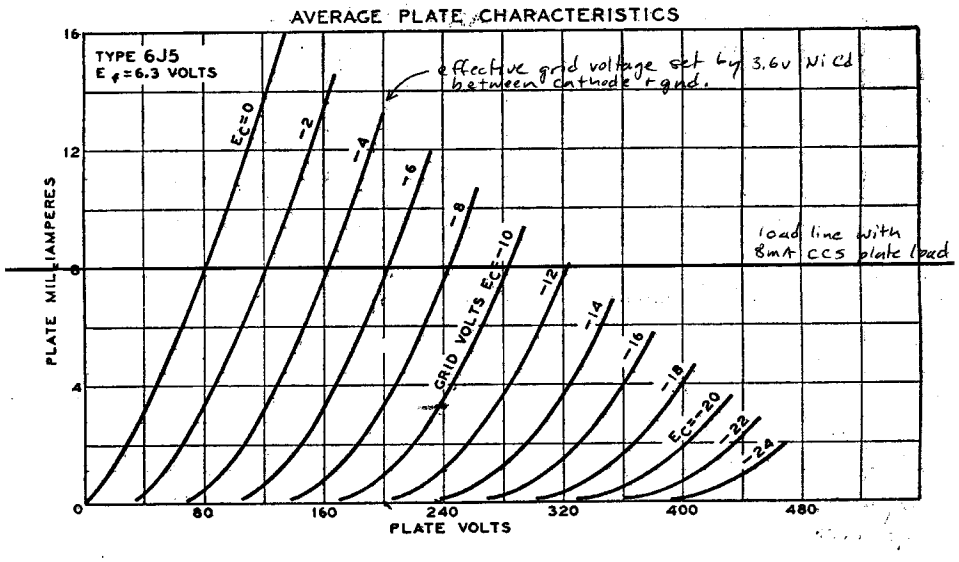
Or 119 ohms for 8 mA. I used a 120 ohm resistor, but ended up with 10 mA; I raised it to 150 to get the 8 mA I wanted.

The value of R3 is given as

R3 = VB+/0.002

Or 175k for a B+ of 350 v. Again, I had to tweak this to 141k to get the current & voltage I wanted. Some day I'll run this through PSPICE to get a better understanding, but for now, it does the job quite well!





constant current source keeps the NiCds in a low trickle-charge state, 8mA, which saves you from having to worry about overcharging the battery. Don't worry about the infamous NiCd memory effect here. The battery's sole purpose in life is to take a charge & stay at the same potential. The only current drawn out of the battery will be during self-discharge, when the amp is turned off

Power Amplifier Stage

The 6J5 is DC coupled to the grid of the 46. Here's another advantage of using a constant-current source. Along with the benefits of linear operation of the preceding stage, the grid of the output tube is set to a fixed value. We still need a cathode resistor, however, since the filament is going to be a couple hundred volts above ground. The cathode resistor is actually comprised of three resistors, bypassed with a 50 uF metallized polypropylene cap. The first resistor is a 5K 25 Watt wirewound. Don't worry about inductance here - it's bypassed by the cap. The next resistor is a 2.5K 5 watt pot, which is used to set the plate current. The bottom resistor is a 100 ohm 2W wirewound, which is there only to provide a measurable voltage drop to use in setting the bias. It's smart to use a 1% or better resistor here, but if you don't want to, the concept will still work as long as you know the exact value of the resistor; the voltage drop times the resistance is your plate current. For example, to set the plate current to 30 mA, we adjust R8 so that we get 3 volts across R9, since 3v /100 ohms is 0.03 amperes. I brought leads out from the current sensing resistor to two spare pins on the front panel tube socket for easy access.

Of course, the plate is supplied B+ through the DC feed choke. The plate is also connected to one side of the output transformer primary. The other side of the primary is connected to a DC blocking cap. The value of this cap is set to 2 uF for good low frequency response. (See sidebar.) At first I connected the other side of the cap to ground, but then just for fun, I tried connecting it to the center tap of the filament transformer, to get it as close as possible to the cathode of the tube. This opened up the sound of the amp quite a lot,so I'm going to leave it that way.

Power Supply

The power supply is a straightforward LCLC design,with a couple of twists added to protect the tubes.

The 46, after all, is an antique radio tube, and they just don't make them anymore. Therefore we want to extend its life as much as possible. Many studies over the years have shown that a major cause of early tube failure is excessive filament voltage, and in DHT power tubes, the filaments are also heavily stressed by the initial current surge caused by the filaments' lower resistance when cold. There's a 105 ohm wirewound resistor in the primary of the two 2.5 volt filament transformers to drop the output voltage to 2.5 volts.

Eventually I will replace this with a negative-temperature-coefficient (NTC) thermistor to protect the filaments from high initial turn-on current. These are available from Digi-Key, although most of them have a much lower on resistance. This configuration is a little different in that I am trying to put the thermistor in the primary rather than the secondary. This has two advantages. First you only need one thermistor. Second,you preserve the center-tap balance of the secondary by not putting anything else between it and the filaments. The 6J5 filaments are also protected by 1 ohm resistors between the filament transformer and the tube filaments. This keeps the filament voltage at 6.3 volts.

The rectifier is a GZ34 for slow warmup. Again, this is to protect the tubes. We want the filaments to get up to temperature

before voltage is applied to the plates to avoid cathode stripping. There is an arrangement in the power supply to prevent cathode stripping at turn-off as well. The power switch is a DPDT, with the spare pole being used to connect a resistor between the B+ and ground when the unit is switched off. This bleeds off the B+ before the filaments cool off too much. A fair amount is dissipated in the resistor, but only for about a second, so it never really heats up that much. Consequently a 5 watt wirewound will be adequate.

The GZ34 is connected to a single 10 Henry choke. This should be a fairly large choke, rated for 100 to 150 mA. Next comes the first filter cap. I used a large aluminum electrolytic in an FP-style can because there's a cutout in the chassis for it. This is followed by a separate 10 Hy at 55 mA choke for each channel. These just fit underneath the chassis in the two rear corners. Following these are two 10 uF metallized polypropylene caps per channel. This arrangement provides very good filtering,and allows us to use reasonably small caps to the plate supplies to keep the amp sounding fast.

Grounding is done with a strip of copper EMI shielding tape stuck onto a strip of teflon. A nice wide, low-impedance ground bus is the result. This also is a major contributor to the amp's good transient response and high-end sweetness. There is a separate ground bus for each channel. Both are tied to the chassis at just one point, the ground lug of the aluminum electrolytic cap.

Room for impr ovement

There's always room for improvement. I decided to leave the amp in its current state for a while to get accustomed to its sound. That way I'll be better able to discern subtle changes when I get back to tweaking it. I must admit, though, at this stage I just like it more every time I listen to it. Perhaps it's still breaking in. Maybe that just means it's too soon to start applying tweaks.

There are some deficiencies, however, which I want to correct eventually. First of all, I don't really have enough voltage across the plate of the 46. This is noticeable on less efficient speakers, particularly on musical peaks where the amp just runs out of steam. It's not a terribly objectionable sound; it's basically just a much higher amount of 2nd order harmonics.

That's an advantage of SE triodes without feedback. Really, the amp sounds great on small ensembles, acoustic jazz, chamber music and especially small vocal ensembles.

Designing passive 600 ohm crosso ver modules

There's a nice reprint of a 1969 AUDIO article in SP Vol. 1 #3, which you should have if you're any kind of self-respecting DIY-er! (1) We'll just suppose you don't feel like digging it out from under the pile of parts and test equipment on your bench. Here's a brief synopsis:

We will be using parallel, m-derived filters. We'll use m = 0.6 for constant impedance over 85% of the transmission band.

Our impedance in & out is 600 Ω.

Crossover frequency: 500 Hz.

Attenuation at crossover: 3 dB

Slope of attenuation: 12 dB/octave

The L.F. filter is comprised of a series inductor, L1, followed by a shunt capacitor, C1. At the output end, we'll put a 600 ohm "L" or "T" stepped attenuator to vary the L.F. output.

The value of L1 is calculated as follows:

L1 = (1+m) Ro/2 pi fc Henry,

Where Ro = 600Ω, the filter's characteristic impedance, and fc = the crossover frequency.

This gives us L1 = 305 mH. You can make one of these yourself if you have some toroid ferrite cores and some magnet wire. Toroids are available from many surplus sources. There are reference materials available on many manufacturer's web sites that allow you to compute the number of turns needed on a given core to get the desired inductance. Arnold Magnetics and Micrometals are two I've used.

For example, take a look at www.grouparnold.com/products/powder/pdf/MPP4-8.pdf for powder cores, and http://www.grouparnold.com/products/wound/pdf/chapter10.pdf for tape-wound cores. Micrometals has a downloadable inductor design program at www.micrometals.com/software.html.

Of course, the best way to finalize your inductor is to measure it on an impedance bridge. If you like to experiment with passive components, it's well worth having one such as the General Radio 1650A, or ESI 650A. They can often be found at hamfests or on ebay.

Ok, so now that we have the inductor, let's figure out the value of the cap, which is:

C1 = 1/(2 pi fc Ro) Farad, or (5.3E-7) Farads X (E-6 uF/Farad) = 0.53 uF

which you can build up with the right combination of parallel capacitors.

Here, too, an impedance bridge comes in handy for getting the final value just right. If you have a lot of caps in your junk box you can get this value by paralleling a 0.47, 0.047, 0.01 and 0.0033.

Now we'll design the H.F. filter. This is comprised of a series capacitor, C2, followed by a shunt inductor, L2. The value of L2 is

L2 = Ro/(2 pi fc) Henry, which works out to 191 mH.

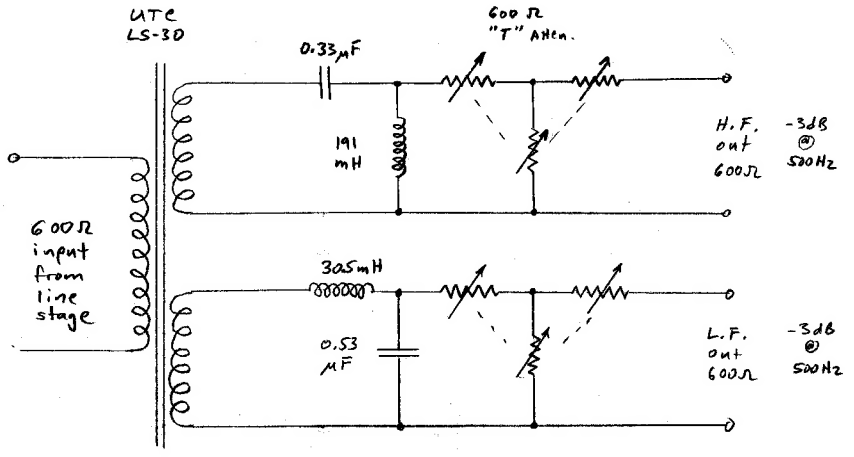
C2 is given by

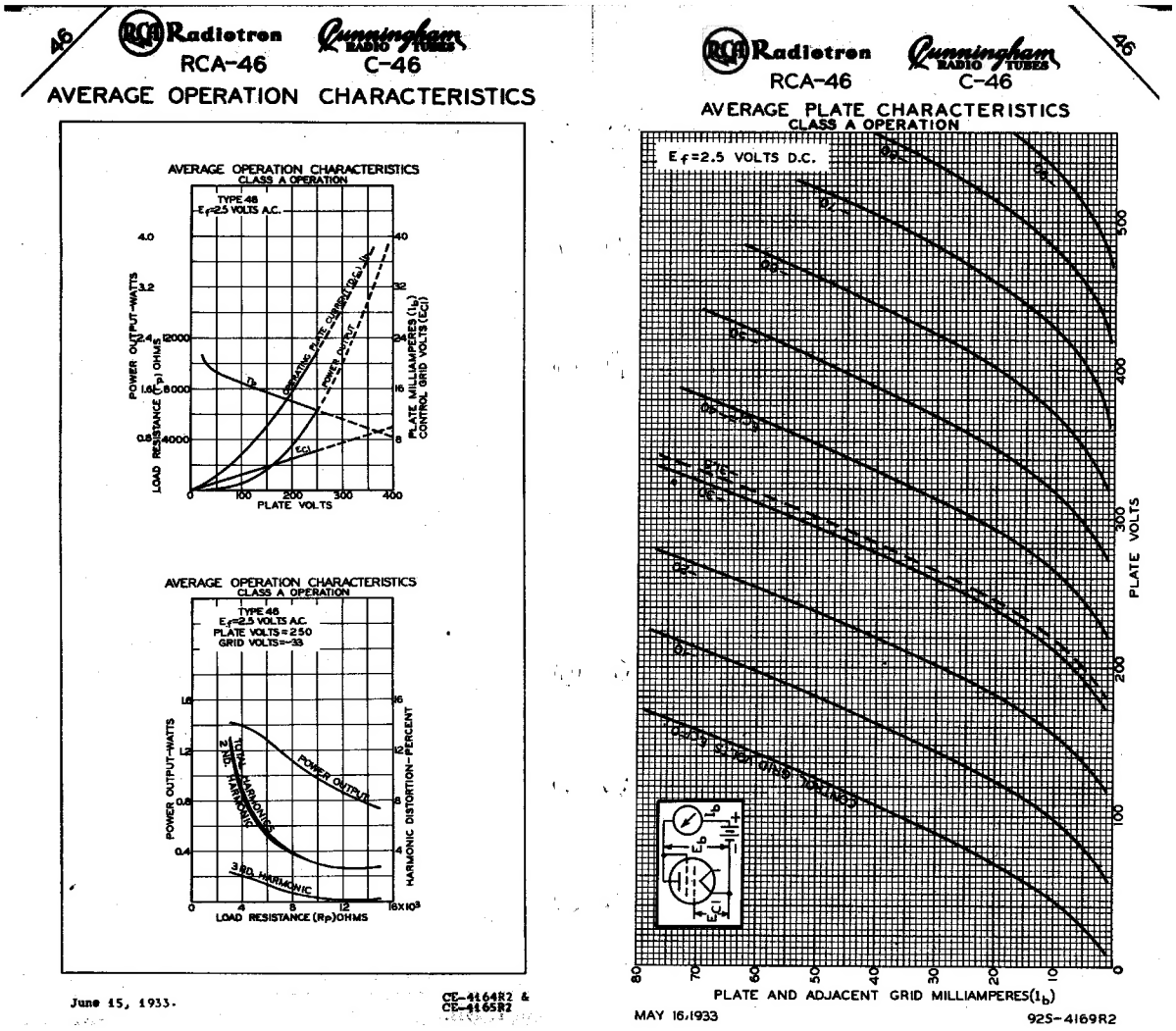
C2 = (1/(1+m))/(1/(2 pi fc Ro)) Farad, or 0.625 times the value of C1, or 0.33 uF, which is, fortunately, a standard value.

Again, since the output is 600 ohms, we can put a 600 ohm attenuator at the output to set the level wherever we want.

1. Another good reference is Attenuators, Equalizers and Filters, by Howard M. Tremaine and George K. Teffeau, Howard K. Sams Photofact Publication AET-1,1956.

Also it's well worth having a copy of Reference Data for Radio Engineers,published by ITT in many editions over the years.





But there are times you wanna rock out, let's face it! I might try raising the B+ by putting a not-too-large cap in front of the first filter choke. There is a range of input cap values, I'm guessing around 0.5 to 1 uF, where you can raise the B+ substantially while retaining the sonic advantages of a choke-input filter. It's also possible that this design is less sensitive to the power supply design due to the isolation provided by the DC feed choke in the output stage and the CCCS in the input stage. If I were building this amp from scratch, I'd use a transformer with a higher plate voltage.

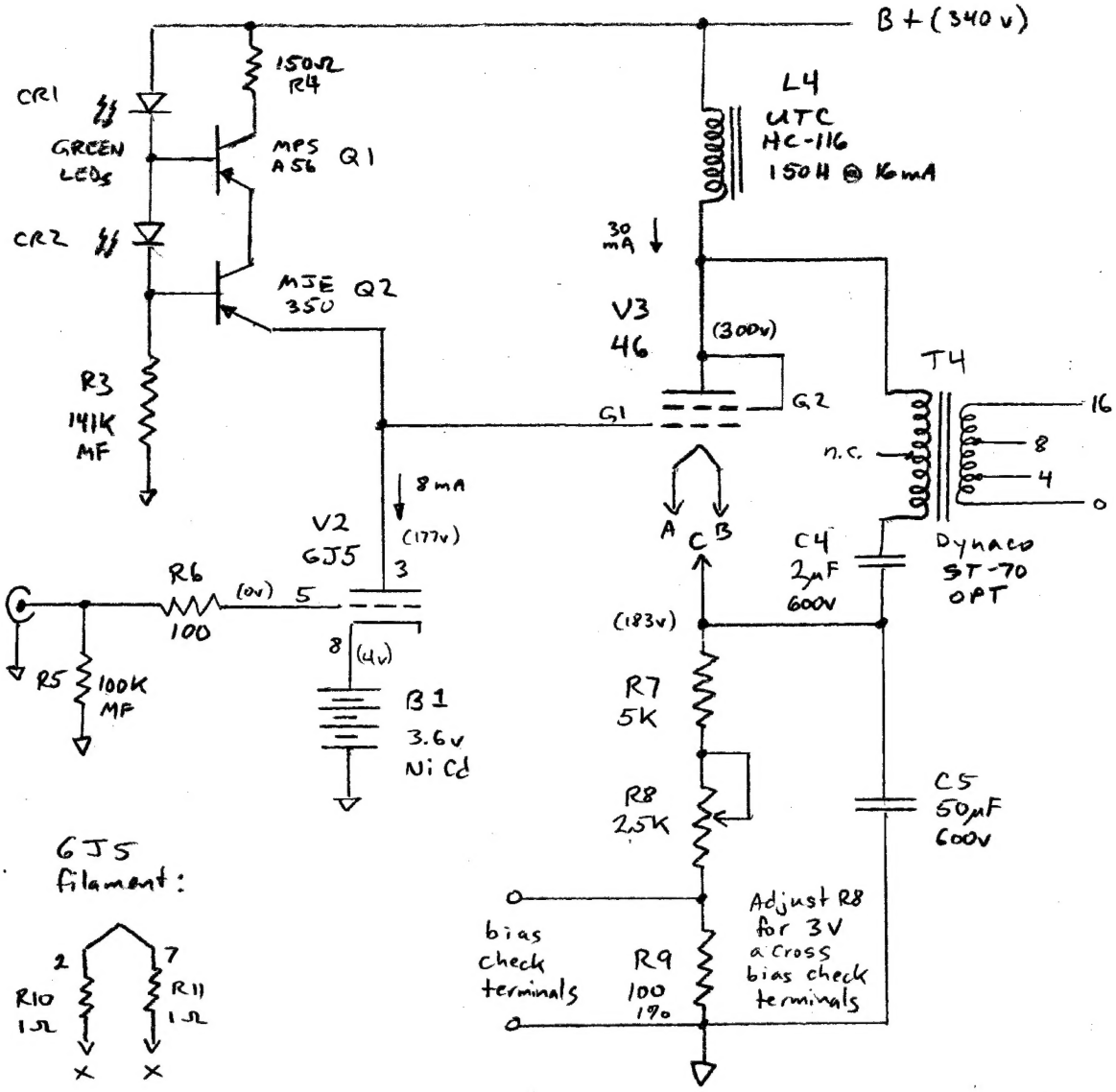
Another thing I want to try is to adjust the CCCS on the 6J5 plate to get the voltage a little lower. This will change the bias to the 46 grid,and allow the cathode voltage to go lower. The effect of this would be a higher plate-cathode voltage.

Second, there is a small amount of hum audible if you put your ear right up to the speaker. I believe that running the 6J5 filament off a DC supply will lower this hum substantially. It should be easily done with a couple of Schottky rectifiers, a filter cap, and an LM317 regulator. I might also try configuring the regulator as a current source. Schottky rectifiers are preferable because they produce much less switching noise than your garden-variety silicon rectifiers like the 1N4000 series. After all, any noise they produce will be reflected back into the power transformer, and could get into the signal path through the plate supply.

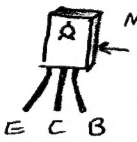
The Sound

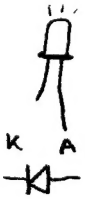
What initially struck me about this amp was its open, natural sound and great frequency extension at both high and low ends. Perhaps this is because it's using a DHT in the output. I've heard criticism of DHT SE amps' lack of punch and a solid bottom end. Well,this amp has the punch! I believe this is due to the parallel-feed arrangement. Keeping DC current out of the output transformer allows a higher inductance, which helps the low-end response. Also I have to admit that these output transformers are high-end overkill for a one watt amp! Of course if a bigger transformer is better, then how much is too much? Who cares if the amp weighs more than most 100 Watt solid state amps? Who even wants to listen to them anyway?

So far I am very pleased with this amp, and I can heartily recommend trying your own version of this with any kind of push-pull iron you have sitting around. The most important thing is to get started on something. A very wise older engineer I once worked with had a saying I will always remember: "Don't wait until you think everything is perfect, just build something now &start testing it!" That's what I did here—and I'm glad I did. Let's keep those soldering irons in their heated state!





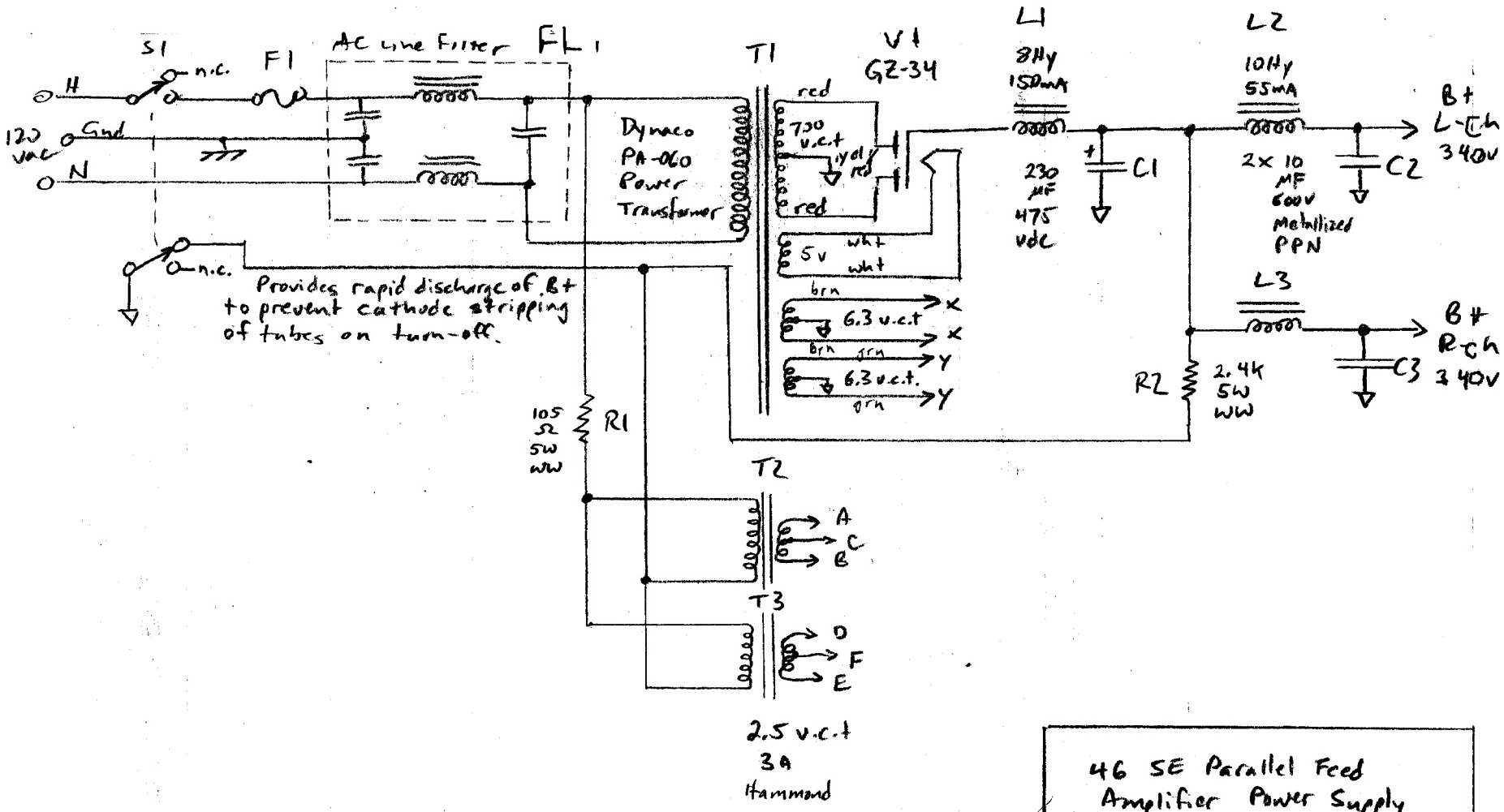




Notes:

1. R10 & R11 are set to adjust 6J5 filament to 6.3 v.
2. Adjust R8 for 30 mA plate current, as measured across R9, 1volt = 10mA
3. Mount Q2 to chassis using iso-pad to prevent shorting collector to ground.
4. All grounds are connected to copper tape ground bus. This is connected to chassis by one wire to electrolytic can gnd.

46 SE
Parallel-Feed
Amplifier
© Ross Lahlum 1999
(one channel shown)
rev. 1 11/17/99 R



46 SE Parallel Feed Amplifier Power Supply

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